A new species of *Amolops* (Anura: Ranidae) from northern Myanmar

DEAR EDITOR,

A new species of the genus *Amolops*, *Amolops putaoensis* **sp. nov.**, is described from northern Myanmar. The new species can be distinguished from its congeners by the following characters: (1) dorsolateral fold distinct; (2) upper-lip stripe white; (3) male body size 37.6–40.2 mm; (4) ground color of dorsal surface brown, flank green, small warts on dorsum; (5) two internal subgular vocal sacs present; (6) HL slightly shorter than HW; (7) two palmar tubercles present, supernumerary tubercles and outer metatarsal tubercle absent; (8) tympanum smaller than half of eye diameter; (9) vomerine teeth present; (10) tibiotarsal articulation reaching beyond snout tip; (11) supratympanic fold indistinct; (12) pineal body present; (13) finger webbing absent, presence of circummarginal groove on tip of first finger; (14) nuptial pads present. The population from Myanmar represented a distinct maternal lineage within the *Amolops monticola* group and was recovered as a sister taxon to *Amolops aniqiaoensis* with strong support (100) based on concatenated data. Average uncorrected pairwise distances (*P*-distances) between the specimens from Myanmar and other species in the genus ranged from 2.69% (vs. *A. aniqiaoensis*) to 12.24% (vs. *A. indoburmanensis*) for 16S rRNA, 6.14% (vs. *A. aniqiaoensis*) to 15.79% (vs. *A. panhai*) for *COI*, and 9.66% (vs. *A. aniqiaoensis*) to 19.52% (vs. *A. afghanus*) for *ND2.*

The genus *Amolops* Cope, 1865 is distributed widely from Nepal and northern India to western and southern China and southward to the Malay Peninsula, with 61 species currently recorded (Frost, 2020; Gan et al., 2020). The *Amolops monticola* species group, characterized by smooth skin, dark side of head with light-colored upper lip stripe extending to axilla, and distinct dorsolateral folds (Jiang et al., 2016; Stuart et al., 2010; Yu et al., 2019; Yuan et al., 2018), currently contains 19 species (Gan et al., 2020), including *Amolops akhaorum* Stuart, Bain, Phimmachak, & Spence, *Amolops aniqiaoensis* Dong, Rao, & Lü, *Amolops archotaphus* (Inger & Chanard), *Amolops bellulus* Liu, Yang, Ferraris, & Matsui, *Amolops chakrataensis* Ray, *Amolops chunganensis* (Pope), *Amolops compotrix* (Bain, Stuart, & Orlov), *Amolops cucae* (Bain, Stuart, & Orlov), *Amolops chayuensis* Sun, Luo, Sun and Zhang, *Amolops daorum* (Bain, Lathrop, Murphy, Orlov, & Ho), *Amolops gerbillus* (Annandale), *Amolops iriodes* (Bain & Nguyen), *Amolops mengdingensis* Yu, Wu, & Yang, *Amolops mengyangensis* Wu & Tian, *Amolops monticola* (Anderson), *Amolops nyingchiensis* Jiang, Wang, Xie, Jiang, & Che, *Amolops tuanjieensis* Gan, Yu, & Wu, *Amolops vitreus* (Bain, Stuart, & Orlov), and *Amolops wenshanensis* Yuan, Jin, Li, Stuart, & Wu. The group is distributed throughout southern and eastern Himalaya, southern China, and mainland Southeast Asia (Yuan et al., 2018), but has not been recorded in Myanmar, where currently seven *Amolops* species are known: i.e., *Amolops afghanus* (Günther), *Amolops kaulbacki* (Smith), *Amolops longimanus* (Andersson), *Amolops marmoratus* (Blyth), *Amolops indoburmanensis* Dever, Fuiten, Konu, and Wilkiinson, *Amolops panhai* Matsui and Nabhitabhata, and *Amolops viridimaculatus* (Jiang) (Dever et al., 2012).

During recent field surveys in northern Myanmar between 2016 and 2017, we collected three *Amolops* specimens resembling species from the *A. monticola* group, i.e., skin smooth, head side dark with light-colored upper lip stripe extending to axilla, and distinct dorsolateral folds. However, they differed from known members of *Amolops* in both morphological and molecular characters. Thus, we considered these specimens to represent a new species of the genus

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Received: 21 May 2020; Accepted: 10 October 2020; Online: 13 October 2020

Foundation items: This work was supported by the Lancang-Mekong Cooperation Special Fund (Biodiversity Monitoring and Network Construction Along Lancang-Mekong River Basin Project), CAS-SEABRI (Y4ZK111B01), National Natural Science Foundation of China (32060114), Key Laboratory of Ecology of Rare and Endangered Species and Environmental Protection (Guangxi Normal University), Ministry of Education (ERESEP2020Z22), and Guangxi Key Laboratory of Rare and Endangered Animal Ecology, Guangxi Normal University (18-A-01-08 and 19-A-01-06)

DOI: 10.24272/j.issn.2095-8137.2020.125

Amolops, which we describe herein.

The *Amolops* specimens collected during field surveys at Putao Township, Kachin State, Myanmar (Figure 1A) were photographed, euthanized, fixed in 75% ethanol, and stored in 75% ethanol. Liver and muscle tissues were preserved in 99% ethanol. Specimens were deposited at Guangxi Normal University (GXNU). *Amolops ricketti* (Boulenger) and *Amolops cremnobatus* Inger & Kottelat were selected as outgroup species according to Gan et al. (2020) and their sequences were downloaded from GenBank.

Total genomic DNA was extracted from the liver and muscle tissues. Tissue samples were digested using proteinase K, and subsequently purified following standard phenol/chloroform isolation and ethanol precipitation. Fragments encoding partial 16S ribosomal RNA (*16S*), partial cytochrome oxidase subunit I (*COI*), and complete NADH dehydrogenase subunit 2 (*ND2*) genes were amplified and sequenced following Yu et al. (2019). All new sequences were deposited in GenBank under accession Nos. MT901382–MT901384 and MT901210–MT901214 (Supplementary Table S1). Sequences were aligned using MUSCLE with default parameters in MEGA 7 (Kumar et al., 2016) and phylogeny was inferred using Bayesian inference. Uncorrected pairwise distances (*P*-distances) between species were calculated in MEGA 7. The best substitution model of the concatenated data of *16S*, *COI*, and *ND2* was selected using Akaike Information Criterion (AIC) in MODELTEST v3.7 (Posada & Crandall, 1998). Bayesian inference was performed in MRBAYES v3.2 (Ronquist et al., 2012) under the selected substitution model: GTR + I + G. Two runs were performed simultaneously with four Markov chains starting from a random tree. The chains were run for 5 000 000 generations and sampled every 100 generations. Convergence and burn-in were checked in Tracer v1.6 (Rambaut et al., 2014). The first 25% of sampled trees were discarded as burn-in and the remaining trees were used to create a consensus tree and to estimate Bayesian posterior probabilities (BPPs).

Morphometric data were taken using digital calipers to the nearest 0.1 mm. Morphological terminology followed the China Wildlife Protection Association (1999). Measurements included: snout-vent length (SVL, tip of snout to vent); head length (HL, tip of snout to rear of jaws); head width (HW, width of head at widest point); snout length (SL, tip of snout to anterior border of eye); internarial distance (IND, distance between nares); interorbital distance (IOD, minimum distance between upper eyelids); upper eyelid width (UEW, maximum width of upper eyelid); eye diameter (ED, diameter of exposed portion of eyeball); tympanum diameter (TD, greater of tympanum vertical and horizontal diameters); forearm and hand length (FHL, elbow to tip of third finger); thigh length (THL, vent to knee); tibia length (TL, knee to heel); tarsus and foot length (TFL, tibiotarsal joint to tip of fourth toe); and foot length (FL, proximal end of inner metatarsal tubercle to tip of fourth toe). Comparative morphological data of congeners were taken from their original descriptions or re-descriptions (Bain et al., 2003; Bain & Truong, 2004; Bain et al., 2006; Biju et al., 2010; Boulenger, 1888; Chinese Zoology Editorial Committee & Chinese Academy of Sciences, 2009; Dever et al., 2012; Fei et al., 2017; Gan et al., 2020; Inger & Chanard, 1997; Inger & Kottelat, 1998; Inger et al., 1999; Jiang, 1983; Jiang et al., 2016; Liu, 1945, 1950; Liu & Hu, 1961, 1975; Liu et al., 2000; Lu et al., 2014; Lyu et al., 2018, 2019a, 2019b; Matsui & Nabhitabhata, 2006; Onn et al., 2018; Orlov & Ho, 2007; Pope, 1929; Pope & Romer, 1951; Pham et al., 2019; Qi et al., 2019; Rao & Wilkinson, 2007; Ray, 1992, 1999; Sengupta et al., 2008; Smith, 1923; Stuart et al., 2010; Su et al., 1986; Sung et al., 2016; Wu & Tian, 1995; Yang, 1991; Yu et al., 2019; Yuan et al., 2018; Zhao et al., 2005).

The obtained alignments of the 16S rRNA, *COI*, and *ND2* genes were 855 bp, 629 bp, 1017 bp, respectively. Average *P*-distances between the specimens from Myanmar and other species in *Amolops* ranged from 2.69% (vs. *A. aniqiaoensis*) to 12.24% (vs. *A. indoburmanensis*) for 16S rRNA (Supplementary Table S2), 6.14% (vs. *A. aniqiaoensis*) to 15.79% (vs. *A. panhai*) for *COI* (Supplementary Table S3), and 9.66% (vs. *A. aniqiaoensis*) to 19.52% (vs. *A. afghanus*) for *ND2* (Supplementary Table S4). The population from Myanmar represented a distinct maternal lineage within the *A. monticola* group and was recovered as a sister taxon to *A. aniqiaoensis* with strong support (100) based on the concatenated data (Figure 1B). Moreover, morphologically these specimens were distinguished from all other species of *Amolops* by a series of characters. Thus, we describe these specimens as a new *Amolops* species.

Taxonomic account

Amolops putaoensis **sp. nov.** (Figure 1C–H; Table 1)

Holotype: GXNU QT20170200, adult male, collected on 9 December 2017 by Tao Qin from a small stream of upper Mali Kha River, Putao County, Kachin State, Myanmar (N27°38'48.7", E97°22'28.7", 544 m a.s.l.).

Paratypes: GXNU W005, adult male, collected from Putao County, Kachin State, Myanmar (N27°34'55.2", E97°5'9.59", 1098 m a.s.l.) on 13 December 2016. GXNU W011, adult male, collected from Putao County, Kachin State, Myanmar (N27°31'12.0", E97°8'31.2", 940 m a.s.l.) on 20 December 2016.

Etymology: The specific epithet is named for Putao Township, where the type locality is located. We suggest the English common name as "Putao cascade frog" and the Chinese common name as "葡萄湍蛙".

Diagnosis: Morphologically, *Amolops putaoensis* **sp. nov.** can be distinguished from its congeners by a combination of the following characters: (1) dorsal skin smooth; (2) dorsolateral fold distinct; (3) head side dark with light-colored upper lip stripe extending to axilla; (4) finger webbing absent, presence of circummarginal groove on tip of first finger; (5) body size of males 37.6–40.2 mm; (6) ground color of dorsal surface brown, flank green, small warts on dorsum; (7) two internal subgular vocal sacs present; (8) two inner palmar tubercles present, supernumerary tubercles and outer

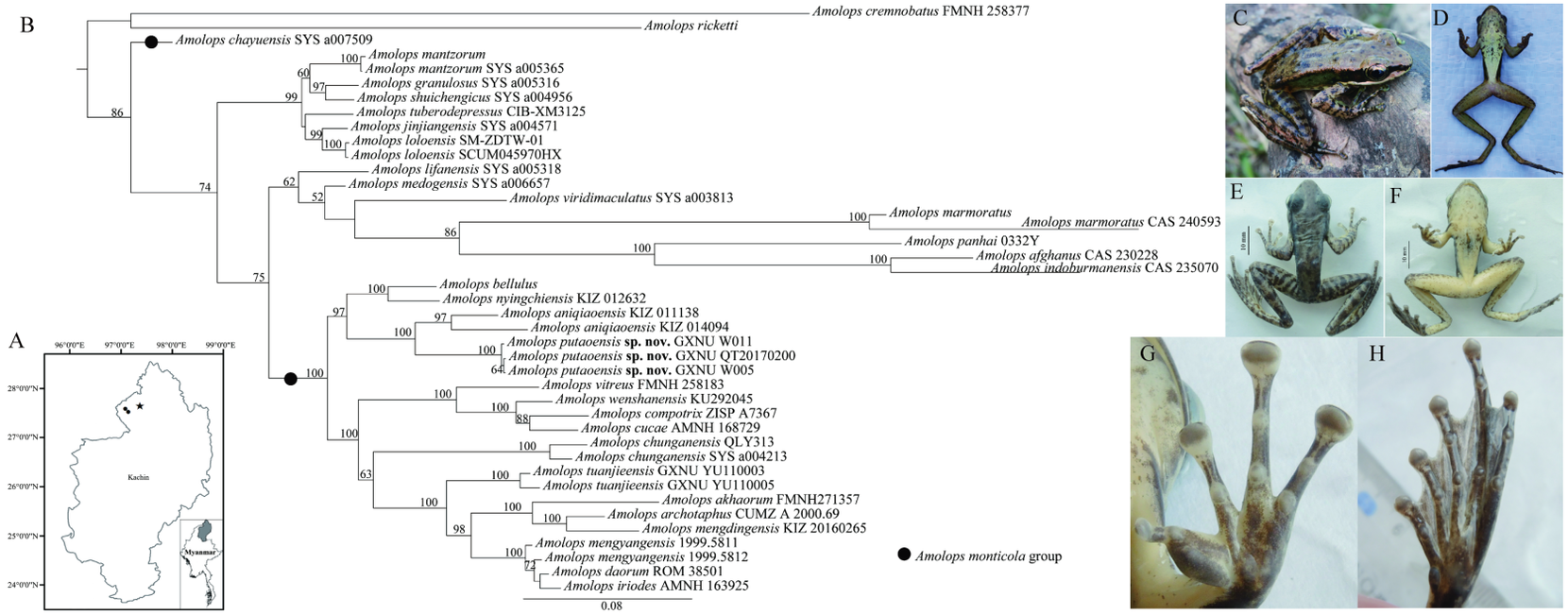

Figure 1 Distribution, phylogenetic position, and holotype of *Amolops putaoensis* sp. nov.

A: Map showing collection sites of *Amolops putaoensis* **sp. nov.** from Putao Township, Kachin State, Myanmar. Star indicates type locality and two circles indicate sampling sites of paratypes. B: Bayesian phylogram of *Amolops* species inferred from combined 16S rRNA, *COI*, and *ND2* data. C, D: Dorsolateral and ventral views of holotype of *Amolops putaoensis* **sp. nov.** (GXNU QT20170200) in life. E, F: Dorsal and ventral views of holotype in preservative. Ventral view of hand (G) and foot (H) of holotype in preservative. (Photos C and D were taken by Tao Qin, photos E–H were taken by Guo-Hua Yu).

Table 1 Morphological measurements (mm) of holotype and paratypes of *Amolops putaoensis* sp. nov.

	GXNU W011	GXNU QT20170200(Holotype)	GXNU W005
Sex	M	M	M
SVL	38.1	40.2	37.6
HL	11.9	13.6	12.9
HW	12.3	13.8	13.4
SL	4.9	5.5	5.1
IND	3.8	4.4	4.2
IOD	3.4	3.9	3.8
UEW	3.2	3.9	3.3
ED	5.3	6.0	5.2
TD	2.3	2.7	2.4
FHL	21.3	21.5	22.7
THL	21.6	21.4	22.2
TL	25.6	23.7	25.2
TFL	33.4	34.3	33.4
FL	20.9	22.6	21.6

See text for abbreviations. M: Male.

metatarsal tubercle absent; (9) tooth-like apophysis on anterior part of lower jaw absent; (10) "/ \"-shaped mark on chest absent; (11) HL slightly shorter than HW; (12) tympanum smaller than half of eye diameter; (13) vomerine teeth present; (14) tibiotarsal articulation reaching beyond snout tip; (15) supratympanic fold indistinct; (16) pineal body present; and (17) nuptial pads present.

Description of holotype (all measurements in mm; see Table 1): Adult male (SVL 40.2 mm); head slightly wider (HW 13.8 mm) than long (HL 13.6 mm); snout obtusely pointed, projecting beyond margin of lower jaw in ventral view, rounded in profile; canthus rostralis distinct, nearly straight; loreal region sloping, concave; nostrils oval, slightly protuberant, closer to snout tip than to eye; internarial distance (IND 4.4 mm) greater than interorbital distance (IOD 3.9 mm); upper eyelid width (UEW 3.9 mm) equal to interorbital distance; pineal spot present; pupil oval, horizontal; tympanum distinct, rounded, less than half eye diameter; supratympanic fold indistinct; vomerine teeth in two oblique rows; maxillary teeth present; choanae oval; tongue attached anteriorly, cordiform, notched posteriorly; vocal sac opening on floor of mouth at each corner; pair of internal subgular vocal sacs present (Figure 1C–F).

Forelimbs robust, relative length of fingers I<II<IV<III; all finger tips expanded into discs with circummarginal and transverse grooves; velvety nuptial pad present on first finger; webbing between fingers absent; subarticular tubercles prominent and rounded, formula 1, 1, 2, 2; supernumerary tubercle absent; two metacarpal tubercles present, oval (Figure G).

Hindlimbs long, heels overlapping when legs positioned at right angle to body, tibiotarsal articulation reaching beyond snout tip; tibia length (TL 23.7 mm) longer than thigh length (THL 21.4 mm) and foot length (FL 22.6 mm); relative length of toes I<II<III<V<IV; dermal fringe on preaxial side of toe I and postaxial side of toe V; all toe tips expanded into discs with circummarginal and transverse grooves, slightly narrower than discs of outer fingers; webbing between toes well developed, webbing formula I1-1.5II1-2III1-2IV2-1V (Myers & Duellman, 1982); subarticular tubercles distinct, formula 1, 1, 2, 3, 2; inner metatarsal tubercle prominent, oval; outer metatarsal tubercle absent; supernumerary tubercle absent (Figure 1H).

Dorsolateral folds distinct, extending from rear of eye to near vent; skin on dorsal and ventral surfaces of head, body, limbs, and flanks smooth, with exception of small white warts on posterior part of dorsum; two rictal glands present, continuous with upper lip; humeral gland absent.

Color of holotype in life: Upper one-fourth of iris bronze with black reticulations, lower three-fourths dark; top of head and dorsum brown with dark spots; head sides black, white upper lip stripe extending to axilla, mottled with red brown; flanks green, scattered with sparse black spots; groin orangish; limbs dorsally brown with dark bars on hindlimbs and lower arms; throat grayish, scattered with irregular dark spots; chest and venter dirty white, scattered with irregular dark spots; ventral surface of limbs grayish with small dark spots; anterior and posterior sides of thigh yellow, scattered with large dark blotches.

Color of holotype in preservative: Dorsal surface grayish brown; throat, chest, abdomen, and ventral surface of limbs faded to white, scattered with brown spots.

Morphological variation: Morphological measurements of holotype and paratypes are presented in Table 1. Because all types are male, sexual dimorphism could not be determined.

Distribution and ecology: The new species is known only from Kachin State, Northern Myanmar. The holotype was found sitting on a branch (*ca.* 0.5 m above the ground) of a withered tree near the bank of a fast-flowing stream. No tadpoles or vocal recordings were collected for the new species.

Comparisons (Supplementary Table S5; Supplementary Note S1): Both morphological characters and phylogenetic analyses indicated that the new species belongs to the *A. monticola* group with strong support. Morphologically, the new species can be distinguished from the 19 congeners in the *A. monticola* group by the following characteristics: (1) body size of males 37.6–40.2 mm (vs. larger male body size in *A. aniqiaoensis* (SVL 52.0 mm) and *A. bellulus* (SVL 45.9–50.1 mm)); (2) vomerine teeth present (vs. absent in *A. daorum*); (3) dorsolateral fold distinct (vs. weak or absent in *A. archotaphus*); (4) tibiotarsal articulation reaching beyond snout tip (vs. reaching tympanum or just posterior to corner of eye in *A. chakrataensis*; reaching end of snout in *A. chunganensis*; reaching end of snout or between eye and snout in *A. mengyangensis*); (5) two internal subgular vocal sacs present (vs. two external vocal sacs present in *A. akhaorum*, *A. cucae*, *A. compotrix*, *A. iriodes*, *A. mengdingensis*, *A. monticola*, *A. tuanjieensis*, *A. vitreus*, and *A. wenshanensis*, and vocal sac absent in *A. nyingchiensis*); (6) webbing between fingers

absent (vs. rudimentary webbing between third and fourth fingers in *A. gerbillus*); (7) dorsal surface brown (vs. green in *A. chayuensis*).

There are seven species of *Amolops* known from Myanmar, including *A. afghanus*, *A. kaulbacki*, *A. longimanus*, *A. marmoratus*, *A. indoburmanensis*, *A. panhai*, and *A. viridimaculatus* (Dever et al., 2012). The new species can be distinguished from *A. afghanus*, *A. kaulbacki*, *A. marmoratus*, *A. indoburmanensis*, *A. panhai*, and *A. viridimaculatus* by dorsolateral fold distinct (vs. absent), two internal subgular vocal sacs present (vs. two external vocal sacs present in *A. afghanus*, *A. marmoratus*, *A. indoburmanensis*, *A. panhai*; and absent in *A. kaulbacki* and *A. viridimaculatus*); and from *A. longimanus* by parotoid-like swelling above tympanum absent (vs. present) and tympanum visible (vs. invisible). The new species further differs from these species by light-colored upper lip stripe present (vs. absent).

Amolops putaoensis **sp. nov.** is distinguishable from the remaining 36 congeners based on the following characters: (1) dorsolateral fold distinct (vs. absent in *A. albispinus* Sung, Hu, Wang, Liu, and Wang, *A. australis* Onn, Abraham, Grismer, and Grismer, *A. caelumnoctis* Rao and Wilkinson, *A. daiyunensis* (Liu & Hu), *A. formosus* (Günther), *A. gerutu* Onn, Abraham, Grismer, and Grismer, *A. hainanensis* (Boulenger), *A. himalayanus* (Boulenger), *A. hongkongensis* (Pope & Romer), *A. larutensis* (Boulenger), *A. lifanensis* (Liu), *A. loloensis* (Liu), *A. mantzorum* (David), *A. minutus* Orlov & Ho, *A. ottorum* Pham, Sung, Pham, Le, Ziegler, and Nguyen, *A. pallasitatus* Qi, Zhou, Lyu, Lu, and Li, *A. ricketti* (Boulenger), *A. sinensis* Lyu, Wang, and Wang, *A. spinapectoralis* Inger, Orlov, and Darevsky, *A. torrentis* (Smith), *A. tuberodepressus* Liu and Yang, *A. wuyiensis* (Liu & Hu), *A. xinduqiao* Fei, Ye, Wang, and Jiang, *A. yatseni* Lyu, Wang, and Wang, and *A. yunkaiensis* Lyu, Wang, Liu, Zeng, and Wang); (2) smaller or larger male body size (SVL 37.6–40.2 mm vs. 52.8–61.5 mm in *A. assamensis* Sengupta, Hussain, Choudhury, Gogoi, Ahmed, and Choudhury, 32–34 mm in *A. cremnobatus* Inger & Kottelat, 43–52 mm in *A. jinjiangensis* Su, Yang, and Li, 42.8–48.6 in *A. kohimaensis* Biju, Mahony, and Kamei, 95 mm in *A. medogensis* Li & Rao, 76.4–82.3 mm in *A. nidorbellus* Biju, Mahony, and Kamei, 62.6–75.6 mm in *A. splendissimus* Orlov & Ho); (3) outer metatarsal tubercle absent (vs. present in *A. jaunsari* Ray); (4) two internal vocal sacs present (vs. absent in *A. shuichengicus* Lyu and Wang); (5) circummarginal groove on tip of first finger present (vs. absent in *A. formosus*); and (6) dorsal surface of limbs smooth (vs. rough with small white spines in *A. granulosus* (Liu & Hu)).

Remarks: Myanmar is an important component of the Indo-Burma biodiversity hot-spot (Conservation International, available at: http://www.biodiversityhotspots.org/xp/Hotspots/indo_burma/) and its northern region lies at a biogeographic crossroads where the faunas of China, Indochina, India, and Himalaya converge (Wogan et al., 2008). However, for nearly half a century, there has been a great shortage of faunal surveys in Myanmar and its herpetofauna remain poorly known. This has hindered our full understanding of the patterns of distribution and evolutionary histories of Asia's amphibian and reptile species.

Although various studies have shown that northern Myanmar is similar to southern Tibet and western Yunnan in amphibian fauna (e.g., Hui et al., 2019; Yu et al., 2018, 2019), the region seems to be a vacuum in terms of *A. monticola* species group distribution, which is widely reported in neighboring regions (e.g., Annandale, 1912; Gan et al., 2020; Jiang et al., 2016; Liu et al., 2000; Yu et al., 2019; Zhao et al., 2005). The discovery of the new species from northern Myanmar in this study fills a gap in the distribution of the *A. monticola* group between eastern Himalaya and southwestern China. Due to the rich diversity of this species group in neighboring countries, it is expected that more species will be discovered in Myanmar.

Like most previous studies, the *A. monticola* group was not recovered as a monophyly in this study, as *A. chayuensis* did not cluster with the clade consisting of other members of the group (Figure 1B). This may be the result of insufficient genetic information in the present data because Wu et al. (2020) recently supported the monophyly of the *A. monticola* group using data generated from anchored hybrid enrichment.

NOMENCLATURAL ACTS REGISTRATION

The electronic version of this article in portable document format represents a published work according to the International Commission on Zoological Nomenclature (ICZN), and hence the new names contained in the electronic version are effectively published under that Code from the electronic edition alone (see Articles 8.5–8.6 of the Code). This published work and the nomenclatural acts it contains have been registered in ZooBank, the online registration system for the ICZN. The ZooBank LSIDs (Life Science Identifiers) can be resolved and the associated information can be viewed through any standard web browser by appending the LSID to the prefixhttp://zoobank.org/.

Publication LSID:

urn:lsid: zoobank.org:pub:59638C61-2262-4CDF-965F-D1FA99E4493D

Amolops putaoensis LSID:

urn:lsid: zoobank.org:act:4013E15C-63A5-48FE-A5C6-832733D58BFF

SCIENTIFIC FIELD SURVEY PERMISSION INFORMATION

Permission for field surveys was granted by the Southeast Asia Biodiversity Research Institute of the Chinese Academy of Sciences (SEABRI, CAS) and Natural Resources and Environmental Conservation of Myanmar.

SUPPLEMENTARY DATA

Supplementary data to this article can be found online.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

G.H.Y., S.L., and R.C.Q. conceived and designed the study. Y.L.G., T.Q., Y.H.L., and G.G.L conducted field surveys. Y.L.G., T.Q., and G.G.L performed the molecular experiments. Y.L.G. measured the specimens, analyzed the data, and prepared the manuscript. All authors read and approved the final version of the manuscript.

ACKNOWLEDGEMENTS

We would like to thank Ya-Ting Liu and Chao-Yi Guan for their technical support.

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REFERENCES

Annandale N. 1912. Zoological results of the Abor expedition, 1911-1912. I. Batrachia. *Records of the Indian Museum*, **8**: 7−36.

Bain RH, Lathrop A, Murphy RW, Orlov NL, Cuc HT. 2003. Cryptic species of a cascade frog from Southeast Asia: taxonomic revisions and descriptions of six new species. *American Museum Novitates*, **3417**: 1−60.

Bain RH, Stuart BL, Orlov NL. 2006. Three new Indochinese species of cascade frogs (Amphibia: Ranidae) allied to *Rana archotaphus*. *Copeia*, **2006**(1): 43−59.

Bain RH, Truong NQ. 2004. Herpetofaunal diversity of Ha Giang Province in northeastern Vietnam, with descriptions of two new species. *American Museum Novitates*, **3453**: 1−42.

Biju SD, Mahony S, Kamei RG. 2010. Description of two new species of torrent frog, *Amolops* Cope (Anura: Ranidae) from a degrading forest in the northeast Indian state of Nagaland. *Zootaxa*, **2408**(1): 31−46.

Boulenger GA. 1888. LXVI.—Descriptions of two new Indian species of *Rana*. *Annals and Magazine of Natural History*, **2**(12): 506−508.

China Wildlife Protection Association. 1999. Atlas of Amphibians of China. Zhengzhou: Henan Science and Technology Press, 432. (in Chinese)

Chinese Zoology Editorial Committee, Chinese Academy of Sciences. 2009. Fauna Sinica: Amphibia Anura. vol. 2. Beijing: Science Press, 957. (in Chinese)

Dever JA, Fuiten AM, Konu Ö, Wilkinson JA. 2012. Cryptic torrent frogs of Myanmar: An examination of the *Amolops marmoratus* species complex with the resurrection of *Amolops afghanus* and the identification of a new species. *Copeia*, **2012**(1): 57−76.

Fei L, Ye CY, Wang YF, Jiang K. 2017. A new species of the genus *Amolops* (Anura: Ranidae) from high-altitude Sichuan, southwestern China, with a discussion on the taxonomic status of *Amolops kangtingensis*. *Zoological Research*, **38**(3): 138−145.

Frost DR. 2020. Amphibian Species of the World 6.0, an Online Reference. New York, USA: American Museum of Natural History. http://research.amnh.org/herpetology/amphibia/index.html/.

Gan YL, Yu GH, Wu ZJ. 2020. A new species of the genus *Amolops* (Anura: Ranidae) from Yunnan, China. *Zoological Research*, **41**(2): 188−193.

Hui H, Yu GH, Yang JX, Rao DQ. 2019. First record of *Minervarya chiangmaiensis* (Anura: Dicroglossidae) from China and Myanmar. *Russian Journal of Herpetology*, **26**(5): 261−266.

Inger RF, Chanard T. 1997. A new species of ranid frog from Thailand, with comments on *Rana livida* (Blyth). *Natural History Bulletin of the Siam Society*, **45**: 65−70.

Inger RF, Kottelat M. 1998. A new species of ranid frog from Laos. *The Raffles Bulletin of Zoology*, **46**(1): 29−34.

Inger RF, Orlov N, Darevsky H. 1999. Frogs of Vietnam: a report on new collections. *Fieldiana Zoology*, **92**: 1−46.

Jiang K, Wang K, Yan F, Xie J, Zhou DH, Liu WL, et al. 2016. A new species of the genus *Amolops* (Amphibia: Ranidae) from southeastern Tibet, China. *Zoological Research*, **37**(1): 31−40.

Jiang YM. 1983. A new species of genus *Staurois* (Ranidae)-*Staurois viridimaculatus*. *Acta Herpetologica Sinica*, **2**(3): 71. (in Chinese)

Kumar S, Stecher G, Tamura K. 2016. MEGA7: molecular evolutionary genetics analysis version 7.0 for bigger datasets. *Molecular Biology and Evolution*, **33**(7): 1870−1874.

Liu CC. 1945. New frogs from west China. *Journal of the West China Border Research Society, Series B*, **15**: 28−44.

Liu CC, Hu SQ. 1975. Report on three new species of Amphibia from Fujian Province. *Acta Zoologica Sinica*, **21**(3): 265−271. (in Chinese)

Liu CC. 1950. Amphibians of Western China. Fieldiana: Zoology Memoirs, 2, 1–400.

Liu CJ, Hu SQ. 1961. Tailless Amphibians of China. Beijing: Science Press, 364. (in Chinese)

Liu WZ, Yang DT, Ferraris C, Matsui M. 2000. *Amolops bellulus*: a new species of stream-breeding frog from western Yunnan, China (Anura: Ranidae). *Copeia*, **2000**(2): 536−541.

Lu B, Bi K, Fu JZ. 2014. A phylogeographic evaluation of the *Amolops mantzorum* species group: Cryptic species and plateau uplift. *Molecular Phylogenetics and Evolution*, **73**: 40−52.

Lyu ZT, Huang LS, Wang J, Li YQ, Chen HH, Qi S, et al. 2019b. Description of two cryptic species of the *Amolops ricketti* group (Anura, Ranidae) from

southeastern China. *Zookeys*, **812**: 133−156.

Lyu ZT, Wu J, Wang J, Sung YH, Liu ZY, Zeng ZC, et al. 2018. A new species of *Amolops* (Anura: Ranidae) from southwestern Guangdong, China. *Zootaxa*, **4418**(6): 562−576.

Lyu ZT, Zeng ZC, Wan H, Yang JH, Li YL, Pang H, Wang YY. 2019a. A new species of *Amolops* (Anura: Ranidae) from China, with taxonomic comments on *A. liangshanensis* and Chinese populations of *A. marmoratus*. *Zootaxa*, **4609**(2): 247−268.

Matsui M, Nabhitabhata J. 2006. A new species of *Amolops* from Thailand (Amphibia, Anura, Ranidae). *Zoological Science*, **23**(8): 727−732.

Myers CW, Duellman WE. 1982. A new species of *Hyla* from Cerro Colorado, and other tree frog records and geographical notes from western Panama. *American Museum Novitates*, **2752**: 1−32.

Onn CK, Abraham RK, Grismer JL, Grismer LL. 2018. Elevational size variation and two new species of torrent frogs from Peninsular Malaysia (Anura: Ranidae: Amolops Cope). *Zootaxa*, **4434**(2): 250−264.

Orlov NL, Ho CH. 2007. Two new species of cascade ranids of *Amolops* genus (Amphibia: Anura: Ranidae) from Lai Chau Province (Northwest Vietnam). *Russian Journal of Herpetology*, **14**(3): 211−228.

Pope CH. 1929. Four New Frogs from Fukien Province, China. New York: The American Museum of Natural History. (in Chinese)

Pope CH, Romer JD. 1951. A new Ranid frog (*Staurois*) from the colony of Hongkong. *Fieldiana Zoology*, **31**: 609−612.

Posada D, Crandall KA. 1998. Modeltest: testing the model of DNA substitution. *Bioinformatics*, **14**(9): 817−818.

Pham AV, Sung NB, Pham CT, Le MD, Ziegler T, Nguyen TQ. 2019. A new species of *Amolops* (Anura: Ranidae) from Vietnam. *Raffles Bulletin of Zoology*, **67**: 363−377.

Qi S, Zhou ZY, Lyu ZT, Lu YY, Wan H, Hou M, et al. 2019. Description of a New Species of Amolops (Anura: Ranidae) from Tibet, China. *Asian Herpetological Research*, **10**(4): 219−229.

Rambaut A, Suchard MA, Xie D, Drummond AJ. 2014. Tracer v1.6. http://tree.bio.ed.ac.uk/software/tracer.

Rao DQ, Wilkinson JA. 2007. A new species of *Amolops* (Anura: Ranidae) from southwest China. *Copeia*, **2007**(4): 913−919.

Ray P. 1992. Two new hill-stream frogs of the genus *Amolops Cope* (Amphibia: Anura: Ranidae) from Uttar Pradesh (India). *Indian Journal of Forestry*, **15**: 346−350.

Ray P. 1999. Systematic studies on the amphibian fauna of the District Dehradun, Uttar Pradesh, India. *Memoirs of the Zoological Survey of India*, **18**(3): 1−102.

Ronquist F, Teslenko M, van der Mark P, Ayres DL, Darling A, Höhna S, et al. 2012. MrBayes 3.2: efficient Bayesian phylogenetic inference and model choice across a large model space. *Systematic Biology*, **61**(3): 539−542.

Sengupta S, Hussain B, Choudhury PK, Gogoi J, Ahmed MF, Choudhury NK. 2008. A new species of *Amolops* (Anura: Ranidae) from Assam, north-eastern India. *Hamadryad*, **32**: 5−12.

Stuart BL, Bain RH, Phimmachak S, Spence K. 2010. Phylogenetic systematics of the *Amolops monticola* group (Amphibia: Ranidae), with description of a new species from northwestern Laos. *Herpetologica*, **66**(1): 52−66.

Su CY, Yang DT, Li SM. 1986. A new species of *Amolops* from the Hengduan Shan Mountains. *Acta Herpetologica Sinica*, **5**(3): 204−206. (in Chinese)

Sung YH, Hu P, Wang J, Liu HL, Wang YY. 2016. A new species of *Amolops* (Anura: Ranidae) from southern China. *Zootaxa*, **4170**(3): 525−538.

Smith MA. 1923. On a collection of reptiles and batrachians from the island of Hainan. *Journal of the Natural History Society of Siam*, **6**(2): 195−212.

Wogan GOU, Vindum JV, Wilkinson JA, Koo MS, Slowinski JB, Win H, et al. 2008. New country records and range extensions for Myanmar Amphibians and Reptiles. *Hamadryad*, **33**(1): 83−96.

Wu GF, Tian WS. 1995. A new *Amolops* species from southern Yunnan. *In:* Zhao E. Amphibian Zoogeographic Division of China. A Symposium Issued to Celebrate the Second Asian Herpetological Meeting Held at Ashgabat, Turkmenistan 6 to 10 September 1995. Sichuan Journal of Zoology, 51–52. (in Chinese)

Wu YH, Yan F, Stuart BL, Prendini E, Suwannapoom C, Dahn HA, et al. 2020. A combined approach of mitochondrial DNA and anchored nuclear phylogenomics sheds light on unrecognized diversity, phylogeny, and historical biogeography of the torrent frogs, genus *Amolops* (Anura: Ranidae). *Molecular Phylogenetics and Evolution*, **148**: 106789.

Yang DT. 1991. Phylogenetic systematics of the *Amolops* group of ranid frogs of southeastern Asia and the greater Sunda Islands. *Fieldiana Zoology*, **63**: 1−42.

Yu GH, Hui H, Rao DQ, Yang JX. 2018. A new species of *Kurixalus* from western Yunnan, China (Anura, Rhacophoridae). *ZooKeys*, **770**: 211−226.

Yu GH, Wu ZJ, Yang JX. 2019. A new species of the *Amolops monticola* group (Anura: Ranidae) from southwestern Yunnan, China. *Zootaxa*, **4577**(3): 548−560.

Yuan ZY, Jin JQ, Li JN, Stuart BL, Wu J. 2018. A new species of cascade frog (Amphibia: Ranidae) in the *Amolops monticola* group from China. *Zootaxa*, **4415**(3): 498−512.

Zhao WG, Rao DQ, Lü SQ, Dong BJ. 2005. Herpetological surveys of Xizang autonomous region 2. *Mêdog*. *Sichuan Journal of Zoology*, **24**(3): 250−253. (in Chinese)

Supplementary Table S1 Sequences and voucher speciemens of Amolops used in this study

Species	Voucher	Locality	*16S*	*CO1*	*ND2*
Amolops akhaorum	FMNH 271357	Vieng Phou Kha, Luang Namtha, Laos	FJ417160	-	FJ417209
Amolops aniqiaoensis	KIZ 011138	Medog, Tibet, China	-	KU243073	-
Amolops aniqiaoensis	KIZ 014094	Medog, Tibet, China	MN953657	MN961354	MN958716
Amolops archotaphus	CUMZ A 2000.69	Doi Inthanon, Chiang Mai, Thailand	FJ417123	-	FJ417172
Amolops afghanus	CAS230228	Kachin, Myanmar	JF794430	-	FJ417205
Amolops bellulus	-	-	FJ417126	KU243079	FJ417175
Amolops chunganensis	QLY313	Shenglongjia, Hubei, China	KF771285	KF771328	KF771328
Amolops chunganensis	SYS a004213	Mt. Jinggang, Jiangxi, China	MG991886	MG991915	-
Amolops compotrix	ZISP A7367	Dak Glei, Kon Tum, Vietnam	FJ417142	-	FJ417191
Amolops cucae	AMNH 168729	Van Ban Dist., Ha Giang Vietnam	FJ417145	-	FJ417194
Amolops chayuensis	SYS a007509	Baxoi County, Xizang, China	MK573820	MK568333	-
Amolops cremnobatus	FMNH 258377	Kasi, Vientiane, Laos	FJ417143	-	FJ417192
Amolops daorum	ROM 38501	Sa Pa, Lao Cai, Vietnam	FJ417150	-	FJ417199
Amolops granulosus	SYS a005316	Mt. Wawu, Sichuan, China	MK604851	MK605609	KF771329
Amolops indoburmanensis	CAS 235070	Twi Rein, Chin, Myanmar	JF794446	-	-
Amolops iriodes	AMNH 163925	Vi Xuyen Dist., Ha Giang, Vietnam	FJ417154	-	FJ417203
Amolops jinjiangensis	SYS a004571	Mt. Gaoligong, Yunnan, China	MK573801	MK568316	-
Amolops putaoensis **sp. nov.**	GXNU QT20170200	Putao, Kachin, Myanmar	MT901382	MT901210	-
Amolops putaoensis **sp. nov.**	GXNU W011	Putao, Kachin, Myanmar	MT901383	MT901211	MT901213
Amolops putaoensis **sp. nov.**	GXNU W005	Putao, Kachin, Myanmar	MT901384	MT901212	MT901214
Amolops loloensis	SM-ZDTW-01	Shimian, Sichuan, China	KT750963	KT750963	KT750963
Amolops loloensis	SCUM045807HX	Xichang City, Sichuan, China	EF453743	-	-
Amolops lifanensis	SYS a005378	Lixian County, Sichuan, China	MK604870	MK605628	-

Table S1 (Continued)

Species	Voucher	Locality	16S	CO1	ND2
Amolops mantzorum	-	Mt. Xiling Snow, Dayi, Sichuan, China	KJ546429	KJ546429	KJ546429
Amolops mantzorum	SYS a005365	Fengtongzhai, Sichuan, China	MK573808	MK568323	-
Amolops marmoratus	-	Thailand	AB211486	-	-
Amolops marmoratus	CAS 240593	Mon, Myanmar	JF794456	-	-
Amolops mengdingensis	KIZ 20160265	Mengding, Yunnan, China	MK501808	MK501811	MK501814
Amolops mengyangensis	1999.5811	Sa Pa, Lao Cai, Vietnam	KR827703	KR087618	-
Amolops mengyangensis	1999.5812	Sa Pa, Lao Cai, Vietnam	KR827704	KR087619	-
Amolops medogensis	SYS a006657	Medog County, Xizang, China	MK573813	MK568328	-
Amolops nyingchiensis	KIZ 012632	Paizhen, Tibet, China	-	KU243071	-
Amolops panhai	0332Y	Kao Chan water fall, Ratchaburi, Thailand	KR827705	KR087620	-
Amolops shuichengicus	SYS a004956	Shuicheng County, Guizhou, China	MK604845	MK605603	-
Amolops tuanjieensis	GXNU YU110003	Tuanjie, Yunnan, China	MN832772	MN832750	MN832755
Amolops tuanjieensis	GXNU YU110005	Tuanjie, Yunnan, China	MN832773	MN832751	MN832756
Amolops tuberodepressus	CIB-XM3125	Jingdong, Yunnan, China	KR559270	KR559270	KR559270
Amolops viridimaculatus	SYS a003813	Mt. Gaoligong, Yunnan, China	MK604836	MK605597	-
Amolops vitreus	FMNH 258183	Phongsaly Dist., Phongsaly, Laos	FJ417163	-	FJ417212
Amolops wenshanensis	KU292045	Jingxi, Guangxi, China	FJ417129	-	FJ417178
Amolops ricketti	-	Wugong Mountain , Jiangxi, China	KF956111	KF956111	KF956111

–: Not available.

Supplementary Table S2 Average uncorrected pairwise distance between members of the *Amolops* genus estimated from 16S rRNA sequences

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 *Amolops putaoensis* **sp. nov.**																
2 *A. akhaorum*	7.35															
3 *A. aniqiaoensis*	2.69	4.00														
4 *A. archotaphus*	6.05	3.31	4.00													
5 *A. afghanus*	12.17	16.79	9.72	16.54												
6 *A. bellulus*	2.98	7.81	2.01	6.84	16.75											
7 *A. chunganensis*	6.68	9.29	2.25	7.67	19.93	7.79										
8 *A. compotrix*	5.38	7.99	3.50	6.82	15.95	6.03	8.29									
9 *A. cucae*	4.73	7.80	2.50	6.63	15.44	6.42	7.59	1.55								
10 *A. chayuensis*	3.95	2.79	3.73	1.68	8.25	2.25	2.23	1.12	1.12							
11 *A. daorum*	5.98	5.27	5.00	4.49	17.72	5.85	7.65	5.64	5.64	2.23						
12 *A. granulosus*	5.26	8.19	4.71	7.02	12.63	5.84	8.64	6.02	6.02	1.57	6.81					
13 *A. indoburmanensis*	12.24	17.05	10.34	17.31	5.42	17.27	20.79	17.22	16.71	8.69	18.51	12.46				
14 *A. iriodes*	6.11	5.27	4.50	4.10	17.47	6.04	7.81	5.84	5.84	2.23	0.58	7.00	17.74			
15 *A. jinjiangensis*	5.11	7.80	4.52	6.82	12.92	5.84	8.89	6.99	6.60	1.76	7.00	1.30	13.05	7.20		
16 *A. loloensis*	5.18	8.23	4.52	7.05	12.92	5.28	8.19	6.83	6.44	2.35	6.45	1.66	12.76	6.65	0.83	
17 *A. lifanensis*	5.40	8.20	4.90	6.25	12.34	5.65	8.41	7.59	7.20	2.94	7.02	4.38	12.90	6.43	4.62	4.51
18 *A. mantzorum*	5.64	7.93	4.71	7.15	13.75	5.38	8.09	7.32	6.93	1.76	7.33	2.55	13.45	7.33	1.84	1.96
19 *A. marmoratus*	11.92	15.09	10.77	14.86	11.39	13.93	14.83	14.70	13.81	8.78	15.14	11.05	12.39	15.26	11.14	11.40
20 *A. mengdingensis*	6.14	3.31	3.77	0.00	14.53	6.84	7.67	6.82	6.63	3.73	4.49	6.28	15.12	4.10	5.92	6.18
21 *A. mengyangensis*	5.93	2.86	5.50	1.82	12.13	2.88	1.69	3.39	2.34	4.17	0.26	5.26	12.90	0.78	4.77	5.26
22 *A. medogensis*	5.39	7.84	4.52	5.88	11.34	5.48	7.69	6.84	6.64	2.75	6.07	3.56	11.60	5.87	4.39	4.63
23 *A. panhai*	11.98	8.33	11.92	8.33	8.03	9.42	16.67	8.33	7.81	10.30	10.42	9.25	8.54	9.90	10.22	10.22
24 *A. shuichengicus*	5.48	7.99	4.90	7.21	13.06	5.84	9.14	6.60	6.60	1.76	6.61	1.18	13.20	6.81	1.54	1.90
25 *A. tuanjieensis*	5.45	5.78	3.67	5.20	13.90	6.85	7.28	6.35	6.35	3.73	3.23	5.99	14.34	3.23	6.23	5.89
26 *A. tuberodepressus*	4.85	7.44	5.27	6.26	13.39	5.08	6.66	6.24	6.24	2.55	6.25	2.01	12.94	6.25	1.66	1.66
27 *A. viridimaculatus*	6.95	10.92	5.65	8.38	13.50	7.98	10.84	9.51	10.29	3.53	8.56	6.62	13.78	8.37	6.50	6.28
28 *A. vitreus*	4.54	8.38	2.50	7.21	16.20	6.61	7.73	2.52	3.30	0.56	6.61	6.60	16.71	6.61	7.57	7.41
29 *A. wenshanensis*	5.25	7.80	3.50	6.63	15.40	6.42	7.17	2.33	1.94	1.12	5.45	6.60	16.45	5.25	6.60	6.44

Table S2 (Continued)

	17	18	19	20	21	22	23	24	25	26	27	28
1 *Amolops putaoensis* **sp. nov.**												
2 *A. akhaorum*												
3 *A. aniqiaoensis*												
4 *A. archotaphus*												
5 *A. afghanus*												
6 *A. bellulus*												
7 *A. chunganensis*												
8 *A. compotrix*												
9 *A. cucae*												
10 *A. chayuensi*												
11 *A. daorum*												
12 *A. granulosus*												
13 *A. indoburmanensis*												
14 *A. iriodes*												
15 *A. jinjiangensis*												
16 *A. loloensis*												
17 *A. lifanensis*												
18 *A. mantzorum*	4.69											
19 *A. marmoratus*	12.20	11.45										
20 *A. mengdingensis*	6.17	6.48	13.70									
21 *A. mengyangensis*	5.75	5.75	12.85	3.30								
22 *A. medogensis*	2.97	4.46	11.	5.71	5.50							
23 *A. panhai*	8.03	11.44	11.20	11.19	12.38	9.25						
24 *A. shuichengicus*	4.73	2.79	11.05	6.28	5.50	4.03	9.98					
25 *A. tuanjieensi*	6.95	6.78	13.10	4.10	3.79	6.24	12.04	6.47				
26 *A. tuberodepressus*	4.27	1.96	10.97	6.18	5.99	4.40	10.71	2.37	6.18			
27 *A.viridimaculatus*	5.80	6.	12.81	7.23	6.97	4.27	11.44	6.38	8.13	6.75		
28 *A. vitreus*	7.59	6.73	14.19	7.21	3.39	7.03	8.33	7.18	6.45	6.43	9.71	
29 *A. wenshanensis*	7.39	6.73	14.04	6.63	2.34	6.84	7.81	6.80	6.35	5.65	10.10	3.88

Supplementary Table S3 Average uncorrected pairwise distance between members of the *Amolops* genus estimated from *COI* sequences

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 *Amolops putaoensis* **sp. nov.**																		
2 *A. aniqiaoensis*	6.14																	
3 *A. bellulus*	8.10	8.99																
4 *A. chunganensis*	12.89	13.28	12.19															
5 *A. chayuensis*	12.82	10.38	11.46	14.28														
6 *A. granulosus*	10.70	11.60	12.15	14.06	10.16													
7 *A. jinjiangensis*	9.83	11.60	11.98	14.66	8.97	5.00												
8 *A. loloensis*	10.86	11.25	11.46	13.70	8.27	5.00	2.72											
9 *A. lifanensis*	11.00	10.39	10.42	10.94	8.65	9.68	10.58	9.78										
10 *A. mantzorum*	10.83	10.99	11.37	13.33	8.54	4.76	4.25	3.11	10.02									
11 *A. mengdingensis*	12.35	11.95	10.76	12.93	12.72	13.06	13.78	12.56	12.34	12.37								
12 *A. mengyangensis*	9.59	9.69	9.81	12.39	12.40	12.58	12.82	13.04	10.26	11.89	10.97							
13 *A. medogensis*	10.68	10.12	9.72	11.29	9.13	9.35	9.94	9.29	4.17	9.05	11.22	9.05						
14 *A. nyingchiensis*	7.87	9.16	4.51	12.11	11.81	11.11	11.11	10.59	8.85	10.16	11.98	9.29	8.16					
15 *A. panhai*	15.79	16.49	14.93	15.03	14.79	14.68	16.51	15.58	15.38	15.08	17.33	16.14	13.94	14.93				
16 *A. shuichengicus*	10.15	11.34	11.11	12.80	9.62	3.55	4.17	4.01	9.62	3.93	14.10	11.86	9.46	10.24	15.71			
17 *A. tuanjieensis*	9.43	10.04	9.72	12.53	12.24	11.45	11.86	11.76	10.26	11.25	10.97	6.52	8.49	9.90	16.06	10.58		
18 *A. tuberodepressus*	11.66	12.21	12.15	13.61	9.06	5.65	5.13	4.93	10.90	4.71	14.47	12.72	10.26	10.94	15.10	4.49	12.40	
19 *A. viridimaculatus*	11.49	11.08	12.33	13.73	10.42	10.16	9.78	10.26	9.78	10.34	14.90	12.26	7.21	11.11	13.94	8.97	11.70	10.42

Supplementary Table S4 Average uncorrected pairwise distance between members of the *Amolops* genus estimated from *ND2* sequences

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 *Amolops putaoensis* **sp. nov.**																		
2 *A. akhaorum*	14.97																	
3 *A. aniqiaoensis*	9.66	14.61																
4 *A. archotaphus*	13.97	9.14	14.38															
5 *A. afghanus*	19.52	15.44	19.89	17.21														
6 *A. bellulus*	10.90	12.78	12.25	12.49	17.40													
7 *A. chunganensis*	13.89	12.04	15.00	12.04	14.81	11.11												
8 *A. compotrix*	15.06	14.26	13.71	14.16	17.90	12.98	15.94											
9 *A. cucae*	14.47	14.06	14.38	12.68	17.99	13.08	14.81	6.19										
10 *A. daorum*	15.36	10.91	13.71	8.95	17.50	11.60	8.33	14.65	14.95									
11 *A. granulosus*	17.41	16.42	18.95	15.92	15.92	10.95	18.52	18.41	18.41	17.41								
12 *A. iriodes*	14.67	11.01	14.16	9.14	17.11	11.01	9.26	14.55	14.45	2.06	16.42							
13 *A. loloensis*	15.56	15.63	16.07	14.85	18.09	13.08	20.37	16.03	16.22	15.93	5.97	15.73						
14 *A. mantzorum*	16.15	15.93	15.69	15.14	18.78	13.08	19.44	16.42	15.63	15.93	2.49	15.63	6.29					
15 *A. mengdingensis*	14.37	10.19	14.27	6.82	17.31	12.66	12.96	13.75	12.76	9.59	15.42	9.50	15.23	15.03				
16 *A. tuanjieensis*	14.27	11.80	13.03	10.23	18.19	11.01	11.11	14.50	14.55	8.46	18.41	9.00	15.78	15.73	11.03			
17 *A. tuberodepressus*	14.87	15.54	14.72	15.24	17.80	12.88	17.59	15.73	16.03	16.22	4.98	15.93	4.82	5.581	15.33	15.29		
18 *A. vitreus*	13.28	13.08	12.47	12.88	16.13	12.19	15.74	8.95	9.93	13.57	18.91	13.18	15.14	15.24	13.85	13.03	14.75	
19 *A. wenshanensis*	13.58	13.57	13.37	12.98	17.40	11.01	14.81	5.70	4.82	13.67	17.41	13.18	15.44	15.34	12.66	13.18	14.85	8.46

Supplementary Table S5 Morphological characters for comparison among the species within Amolops monticola group

Species	SVL (MM)	Dorsal color	Vocal sac in males	Nuptial pad in males	Tympanum	Pineal body	Flank color	Vomerine teeth
Amolops putaoensis **sp. nov.**	37.6–40.2 (♂)	brown	two internal subgular vocal sacs	present	present	present	green	present
A. akhaorum	34.9–37.2 (♂), 58.8–62.5 (♀)	green	two internal subgular vocal sacs	absent	distinct	present	marbled black with cream	weakly developed
A. aniqiaoensis	52 .0 (♂)	olive green	two external subgular vocal sacs	present	present	-	olive green or sauce brown	present
A. archotaphus	38.2–42.1(♂), 58.8–62.5 (♀)	olive green	present	present	present	present	olive green	in small oblique groups near midline of palate.
A. bellulus	46.0–50.0 (♂), 64.0 (♀)	olive green	absent	present	distinct	-	light bluish green to olive green	two short rows
A. chunganensis	34.0–39.0 (♂), 44.0–54.0 (♀)	reddish brown	present	present	present	-	green, below milky yellow with brown cloud spots	in two oblique rows between choanae, closer to each other than to choanae

Table S5 (Continued)

Species	SVL (MM)	Dorsal color	Vocal sac in males	Nuptial pad in males	Tympanum	Pineal body	Flank color	Vomerine teeth
A.chakrataensis	55.0 (♀)	slaty brown	-	-	present	present	dark green	feeble, arranged obliquely in groups
A. compotrix	31.4–42.6 (♂), 55.6–56.9 (♀)	blue-green to yellowish green	two internal subgular vocal sacs	present	present	present	light brown marbled with creamy-white	strongly developed, on two oblique ridges, equal in distance from each other as to choanae
A. cucae	40.7–44.6 (♂), 65.8–68.0 (♀)	light green	two internal subgular vocal sacs	present	present	absent	dark brown anteriorly, diffusing to yellowish-brown	strongly developed, on two oblique ridges, equal in distance from each other as to choanae
A. chayuensis	41.24 (♂), 51.44 (♀)	grass green	-	-	distinct	-	green(♀), light green and brown spots (♂)	short, arranged on the line of the inner nostril in the form of a "parallel head"
A. daorum	32.0–38.1 (♂), 53.3–57.6 (♀)	green	present	present	present	present	brown	absent
A. gerbillus	33 (sex unknown)	dark gray	-	-	present	-	sides pale	weak and small

Table S5 (Continued)

Species	SVL (MM)	Dorsal color	Vocal sac in males	Nuptial pad in males	Tympanum	Pineal body	Flank color	Vomerine teeth
A. iriodes	38.8–39.4 (♂), 61.9 ♀)	iridescent green or green-gold	present	absent	present	present	flanks with white glandular spot	crescent-shaped
A. mengdingensis	36.9–40.2 (♂), 64.3 (♀)	light green with some dark spots	two external vocal sacs	present	distinct	absent	brown	in two oblique rows between choanae, closer to each other than to choanae
A. mengyangensis	39.0–40.0 (♂), 60.0 (♀)	olive green	two external vocal sacs	present	present	-	-	short and weak, sloping from the medial or posterior margin of the inner nostril toward the midline
A. monticola	41.0 (♂)	brown	present	present	present	-	the front half is dark brown and the back half is dark green	in two oblique rows between choanae, closer to each other than to choanae
A. nyingchiensis	52.3–58.3 (♂), 57.6–70.7 (♀)	light brown or yellowish brown	absent	present	distinct	-	grey and olive-green with black spots	indistinct

Table S5 (Continued)

Species	SVL (MM)	Dorsal color	Vocal sac in males	Nuptial pad in males	Tympanum	Pineal body	Flank color	Vomerine teeth
A. tuanjieensis	39.5-40.4 (♂), 56.8-60.7 (♀)	brownish red with irregular black and gray spots	two external vocal sacs	present	distinct	present	green with black spots	in two oblique rows between choanae, closer to each other than to choanae
A. vitreus	37.5–43.6 (♂)	green	present	present	present	absent	upper portion of flank graygreen with brown spots as on dorsum; lower half of flank creamy white, with brown mottling in preservative.	strongly developed, on two oblique ridges, equal in distance from each other as to choanae
A. wenshanensis	35.7–39.9 (♂), 43.7–45.6 (♀)	green	present	present	distinct	present	-	short

Table S5 (Continued)

Species	dorsolateral fold	All fingers expanded	circummarginal groove on the tip of first finger	outer metatarsal tubercle	inner palmar tubercles	tibiotarsal articulation reaching beyond snout tip
Amolops putaoensis **sp. nov.**	distinct	yes	present	absent	oval	yes
A. akhaorum	distinct	yes	present	absent	no	-
A. aniqiaoensis	distinct	yes	present	absent	-	yes
A. archotaphus	absent	outer three fingers expanded	absent	present	-	-
A. bellulus	distinct	outer three fingers expanded	absent	absent	no	yes
A. chunganensis	distinct	outer three fingers expanded	present	absent	-	no
A.chakrataensis	distinct	yes	present	absent	elongated	no
A. compotrix	distinct	yes	present	present	oval	-
A. cucae	distinct	yes	present	present	oval	-
A. chayuensis	distinct	yes	present	absent	present	yes
A. daorum	indistinct	yes	present	absent	-	-
A. gerbillus	distinct	yes	-	absent	-	yes
A. iriodes	distinct	yes	present	absent	-	-

Table S5 (Continued)

Species	dorsolateral fold	All fingers expanded	circummarginal groove on the tip of first finger	outer metatarsal tubercle	inner palmar tubercles	tibiotarsal articulation reaching beyond snout tip
A. mengdingensis	distinct	yes	present	absent	oval	yes
A. mengyangensis	distinct	yes	present	absent	-	no
A. monticola	indistinct	yes	present	absent	oval	yes
A. nyingchiensis	distinct	yes	present	absent	no	yes
A. tuanjieensis	distinct	yes	present	absent	oval	yes
A. vitreus	distinct	yes	present	present	oval	-
A. wenshanensis	distinct	yes	present	absent	oval	-

-: morphological characters is not known or not clearly defined in the literature.

Supplementary notes S1: Key to new species and its congeners

1 Dorsal color dark gray.....*Amolops gerbillus*
Dorsal color green or brown.....2
2 Dorsolateral fold absent.....*Amolops archotaphus*
Dorsolateral fold distinct or indistinct.....3
3 “U”-shaped spot on chest present.....*Amolops chayuensis*
“U”-shaped spot on chest absent or “/ \”-shaped mark on chest present.....4
4 Circummarginal grooves on tip of finger I absent.....*Amolops bellulus*
Circummarginal grooves on tip of finger I present.....5
5 Vomerine teeth absent.....*Amolops daorum*
Vomerine teeth weakly or strongly developed.....6
6 Outer three fingers expanded.....*Amolops chunganensis*
All fingers expanded.....7
7 Dorsolateral fold indistinct.....*Amolops monticola*
Dorsolateral fold distinct.....8
8 Supratympanic fold present.....*Amolops chakrataensis*
Supratympanic fold absent.....9
9 Vocal sac in males absent.....*Amolops nyingchiensis*
Vocal sac in males present.....10
10 Skin on venter translucent.....*Amolops virtreus*
Skin on venter not translucent.....11
11 Relative length of fingers I ≈ II < IV < III ..... *Amolops mengyangensis*
Relative length of fingers I < II < IV < III.....12
12 Relative length of toes I < II < III = V < IV.....*Amolops iriodes*
Relative length of toes I < II < III < V < IV.....13
13 Nuptial pad in males absent.....*Amolops akhaorum*
Nuptial pad in males present.....14
14 “/ \”-shaped mark on chest present.....*Amolops aniqiaoensis*
“/ \”-shaped mark on chest absent.....15
15 Indistinct transverse bands on dorsal surfaces of limbs.....*Amolops wenshanensis*
Distinct transverse bands on dorsal surfaces of limbs.....16
16 Dorsal spots absent.....*Amolops compotrix*
Dorsal spots present.....17
17 Outer metatarsal tubercle present.....*Amolops cucae*
Outer metatarsal tubercle absent..... 18
18 Dorsal color green.....*Amolops mengdingensis*
Dorsal color brown.....19
19 Two external vocal sacs present.....*Amolops tuanjieensis*
Two internal subgular vocal sacs present..... .....*Amolops putaoensis* **sp. nov.**