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A new locality and elevation extension for *Megophrys rubrimera* in Bat Xat Nature Reserve, Lao Cai Province, northern Vietnam

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Megophrys rubrimera Tapley et al., 2017 was recently described from two localities in northern Vietnam and southern China (Sa Pa District, Lao Cai Province, northern Vietnam, and Jinping County, Yunnan Province, southwest China at elevations of 1400 - 1722 m a.s.l.). The species is only known from a relatively small area of forest, and the Area Of Occupancy (AOO) and Extent Of Occurrence (EOO) were predicted to be 385 km² and 2298 km² respectively (Tapley et al., 2017). *Megophrys rubrimera* is thought to be forest-dependent, and forest-loss within its predicted range is ongoing, likely making the species Endangered in accordance with the IUCN Red List of Threatened Species (IUCN, 2012).

On the 08 September 2017, during fieldwork in the Hoang Lien Range (Mount Ky Quan San, Bat Xat Nature Reserve, Bat Xat District, Lao Cai Province, Vietnam; 22.30343°N, 103.37019°E, 2153 m a.s.l.), four megophryid specimens were collected in a swampy area beside the headwaters of a stream. Tissue samples (liver) for molecular analyses were removed from freshly euthanised specimens prior to formalin fixation.

We recorded morphological data (to the nearest 0.1 mm) with digital callipers from specimens fixed in 10% formalin and then stored in 70% ethanol. Measurements and morphometric abbreviations follow Mahony et al., (2011). Sex and maturity was determined by the presence/absence of nuptial pads and gonadal inspection. Body mass was recorded in life (to the nearest 0.1 g), using Pesola® scales. Specimens were deposited at the Australian Museum, Sydney (AMS), and the Hoang Lien National Park museum (HLNP).

Specimens were identified morphologically as *M. rubrimera* (Fig. 1) based on the following characters: (1) small size, SVL less than 31 mm; (2) small palpebral horn on upper eyelid; (3) toes lacking interdigital webbing but possessing narrow lateral fringes; (4) groin, inner surface of thighs and outer surface of shanks red-orange; (5) absence of subarticular tubercles on fingers and toes; (6) red-orange inner metatarsal tubercle; and (7) weakly defined vomerine ridges with teeth. All collected individuals were sexed as female due to the presence of ovaries; two individuals (AMS R186128

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Figure 1. Female *Megophrys rubrimera* (AMS R186128) in life.

and AMS R186130) were gravid. Species identity was also confirmed using molecular analysis (see Tapley *et al.*, 2017 for molecular methods).

An updated species range map was created in ArcMap 10.2.2 (Fig. 2) and the elevation range within which *M. rubrimera* is likely to occur was estimated by adding a buffer of 50 m to the lowest and highest known elevation records of the species (Tapley *et al.*, 2017). Areas of habitat were deemed suitable and included in maps if they are within the species' estimated elevation range; are covered with forest; and, are not separated from known localities by any continuous stretch of unsuitable habitat with a distance equal to or above 1 km. EOO was measured using the IUCN EOO Calculator tool v1.2.

The female specimens collected on Mount Ky Quan San varied from the all-male type series of *M. rubrimera*: SVL 26.6–30.8 mm (vs. SVL 26.7–30.5 mm; Tapley *et al.*, 2018); tympanum diameter/eye diameter 67–83% (vs. 58.0–76.0%; Tapley *et al.*, 2017); shank length/snout vent length 52–58% (vs. 48.0–56.0%; Tapley *et al.*, 2018); head width/snout vent length 36–38% (vs. 38.0–42.0%; Tapley *et al.*, 2017) and head length was greater than head width only in AMS R186128 and HLNP 20170910 00005, whereas in the type series the head width was greater than the head length in all specimens. Colouration was consistent with the type series. These are the first reported female specimens

of *M. rubrimera*. Sexual size dimorphism is common in the genus *Megophrys* with females often being considerably larger than males (e.g. Wang *et al.*, 2017). On the basis of the four adult female specimens there appears to be no obvious sexual size dimorphism in this species. We did not observe any *Megophrys* larvae during our surveys in September 2017 and the breeding season of this species remains unknown.

Sequences generated from these four adult specimens did not differ from each other but differed from specimens collected 21 km away in Sa Pa District, Lao Cai Province, Vietnam by 0.5% uncorrected *p*-distance at the 16S rDNA fragment examined (~530bp) and by 1.0% from a specimen collected at least 15 km from Maandi, Jinping County, Yunnan Province, China (Chen *et al.*, 2017); this is congruent with intraspecific variation reported elsewhere within the subgenus and species (e.g. Li *et al.*, 2014). New sequences were deposited in GenBank under the accession numbers MH400908–MH400911.

This new site record occurs within the predicted range of the species (Tapley *et al.*, 2017) but this record increases the elevation range of the species by 430 m a.s.l. The estimated EOO has been significantly increased by 1857 km² (from 2208 km² to 4065 km²). Ongoing disturbance to the species' habitat due to grazing of domestic livestock and forest clearance for agriculture are threats to *M. rubrimera* at this new locality. Forest at the collection site on Mount Ky Quan San is also negatively impacted by ecotourism; there is a tourist camp less than 1 km away and we observed people operating the camp cutting trees for fuel wood on a daily basis in September 2017. Tourism has been cited as a threat to other range restricted amphibian species in the Hoang Lien Range (IUCN SSC, 2015a; IUCN SSC, 2015b). The new locality falls within a newly designated reserve, and it is imperative that strategies are developed to minimise the impact of habitat loss, habitat degradation and tourism on amphibian populations before the forest is irreparably damaged. Despite a considerable increase in the estimated EOO, *M. rubrimera* will still likely qualify as Endangered (IUCN, 2012) in accordance with the IUCN Red List of Threatened Species categories and criteria B1ab(iii). The data herein are presented for easy assimilation into a Red List assessment for the species by the regional IUCN amphibian Red List authority (after Tapley *et al.*, 2018).

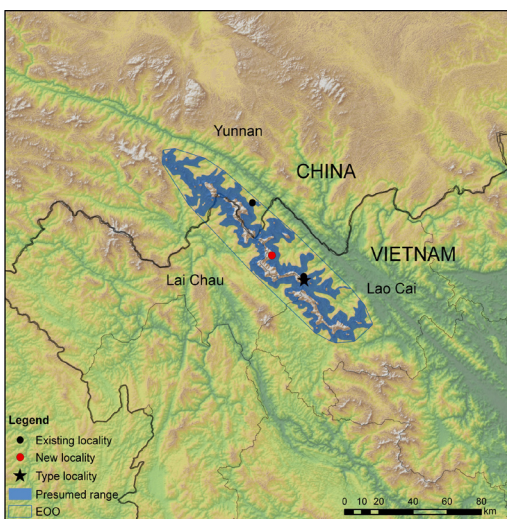


Figure 2. Distribution of *Megophrys rubrimera* in the Hoang Lien Range, northern Vietnam and Ailao Mountain Range in Yunnan Province, southwest China.

Table 1. Measurements (mm) of *Megophrys rubrimera*.

Voucher #	AMS R186128	AMS R186129	AMS R186130	HLNP 20170910 00005
Genbank accession #	MH400908	MH400909	MH400910	MH400911
Sex	F	F	F	F
SVL	28.8	30.6	30.8	26.6
HW	10.8	11.1	11.7	9.7
HL	11.7	11	11.3	9.8
IFE	3.1	3.8	3.6	3.4
IBE	4.8	3.4	3.7	3.4
EL	2.9	2.7	3.2	2.6
TYD	2.9	2.5	2.4	2.7
TYE	2.0	1.8	2.0	1.8
SL	3.8	4.2	4.3	3.8
EN	1.6	1.6	2.1	1.9
SN	2.2	2.6	2.8	2.6
IUE	3.2	4.3	3.5	3.1
IN	3.2	3.7	3.1	2.9
UEW	3.2	3.4	3.6	3.3
FAL	6.7	6.5	6.5	6.2
HAL	8.1	8.4	8.7	7.6
FIL	3.4	3.0	3.4	2.9
FIIL	3.6	3.1	3.5	3.3
FIIL	4.6	5.2	4.8	4.5
FIVL	2.6	3.5	3.3	2.4
SHL	15.7	16.5	15.9	15.3
TL	14.8	14.8	15.9	13.3
FOL	14	13.8	15.1	13.3
IMT	2.4	2.3	2.4	2.4
Mass in life (g)	2.8	3.2	3.0	1.6

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Appendix I.

Comparative material examined:

Megophrys rubrimera ($N=8$), all specimens collected in Sa Pa District, Lao Cai Province, Vietnam : VNMN 2017.002, (22.38205°N, 103.78745°E, 1708 m); VNMN 2017.002, AMS R177676 (22.39829°N, 103.78545°E, 1400 m a.s.l.); AMS R177675, (22.38208°N, 103.78699°E, 1722 m a.s.l.), AMS R177677–9 (22.3809°N, 103.78798°E, 1714 m a.s.l.) and HNLP2016062200001 (22.38208°N, 103.78699°E, 1722 m a.s.l.).