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Habitat evaluation and conservation framework of the newly discovered and critically endangered black snub-nosed monkey

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ABSTRACT

The black snub-nosed monkey (*Rhinopithecus strykeri*) is an IUCN-Critically Endangered primate, recently discovered on the northern Sino-Myanmar border. In order to identify the most urgent gaps in the conservation of the black snub-nosed monkey, a hierarchical process was employed to predict the distribution and alterations in its habitat over the past 15 years. Our study showed that *R. strykeri* appeared to inhabit a range from E98°20′–98°50′, N25°40′–26°50′, including high quality habitat at 1420 km^2, medium quality habitat at 750 km^2, and low quality habitats at 1410 km^2. Only 21.1% of the total habitat for *R. strykeri* is within protected areas in China. Approximately 2.6% of the entire habitat has been lost in the past 15 years, 96% of which has been in Myanmar. To save this species from extinction, it is urgent to establish trans-boundary conservation and management networks to address the loss of habitat, and to locate and preserve key wildlife corridors to link fragmented habitats between Myanmar and China.

1. Introduction

The recently described black snub-nosed monkey (*Rhinopithecus strykeri*), alternatively known as the Myanmar or Nujiang snub-nosed monkey, is found in the high altitude forests of north-eastern Kachin state, Myanmar (Geissmann et al., 2011) as well as in the middle segment of the Gaoligong Mountains, Yunnan, China (Long et al., 2012; Yang et al., 2016). There are up to 14 groups (10 in China and 4 in Myanmar, <950 individuals) of black snub-nosed monkeys living in the northern Sino-Myanmar border area according to interviews (Geissmann et al., 2011; Ma et al., 2014). As a slow breeding species, combined with the prevalence of hunting and the extensive loss of habitat, this species is likely experiencing a rapid demographic decline (Geissmann et al., 2011). With the booming economy and population growth of the region, deforestation for agricultural cultivation and infrastructure development pose potential perils to this IUCN-Critically Endangered primate.

To save this species from the brink of extinction, it is important to study its habitat and its distribution, but, due to the extreme ruggedness of the terrain and the long wet season, almost no information on population distribution and habitat status are available for conservation planning. Where the data are poor in given study areas, employing MAXENT can offer reliable assessments for a species' possible distribution, and can support conservation planning (Thorn et al., 2009; Peck et al., 2011; Ingberman et al., 2016) by prioritizing appropriate habitats for new protected areas (Urbina-Cardona and Loyola, 2008; Campos and Jack, 2013) or guiding prospective land use planning and management (Illera et al., 2010), by identifying least-cost corridors for habitat connectivity (Liu et al., 2016; Luo et al., 2016; Schaffer-Smith et al., 2016), and by pinpointing ideal reintroduction sites (Thorn et al., 2009; Cilliers et al., 2013). The function of MAXENT is to generate a model across one study area based on existing information concerning environmental variables which is then used in another area to make predictions and inference of maximum entropy occurrence under similar environmental constraints (Phillips and Dudík, 2008; Thorn et al., 2009; Araújo and Peterson, 2012). Compared to other ecological niche algorithms, MAXENT as a present-only model can moderately offset for imperfect, limited species occurrence data sets and reach near-maximum accuracy levels under these circumstances (Hernandez et al., 2006, 2008; Giovanelli et al., 2010).

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Based on climatic variables and two sets of locality records obtained by interview-based survey (Geissmann et al., 2011; Ma et al., 2014; Fig. 1), a MAXENT model was built up to map the habitat of *R. strykeri*. Forest cover maps in the 2000s and 2015, based on Landsat images, were used to mask out non-woodland areas from the habitat. We then assessed habitat changes from 2000 to 2015. According to the results, we identified additional areas where *R. strykeri* may occur, proposed specific conservation priorities, and determined crucial areas in which urgent protection measures should be taken to ensure the long survival of this rare and little known primate.

2. Methods

2.1. Study area

The Gaoligong Mountains rise from the low altitude (183 m) drainage of the N'mai River in Myanmar to an altitude of 6318 m in the southeast of Zayü County (Chaplin, 2005). The altitudinal gradient yields a vertical zonation of climate, soil composition and solar radiation, generating diverse vegetation types and a rich flora and fauna diversity (ibid). The vegetation in the Gaoligong Mountains, from the valleys to the peaks, goes from tropical monsoon forest (<1000 m a.s.l.), monsoon evergreen broad-leaved forest (1100–1800 m), semi moist evergreen broad-leaved forest (1700–2500 m) and mid-montane moist evergreen broad-leaved forest above (1900–2800 m), coniferous broadleaved mixed forest (2700–3500 m), to the alpine bush zone (>3400 m) (Li et al., 2000).

According to Geissmann et al. (2011) and Ma et al. (2014), the known and potential *R. strykeri* populations are restricted to a narrow range of 98°20′–98°49′E, 25°58′–26°31′N. Two insurmountable natural barriers, the N'Mai Hka and Salween Rivers, would appear to have physically blocked their expansion to other areas. Thus, the study area for this project ranged from the China State Road 320 (named Road NH3 in Myanmar) in the south to the provincial border between Yunnan and the Tibet Autonomous Region in the north, and from the N'Mai Hka River in the west to the Salween River in the east, with a total area of about 41,350 km^2 (97.05–98.91E, 24.02–28.40 N, Fig. 1).

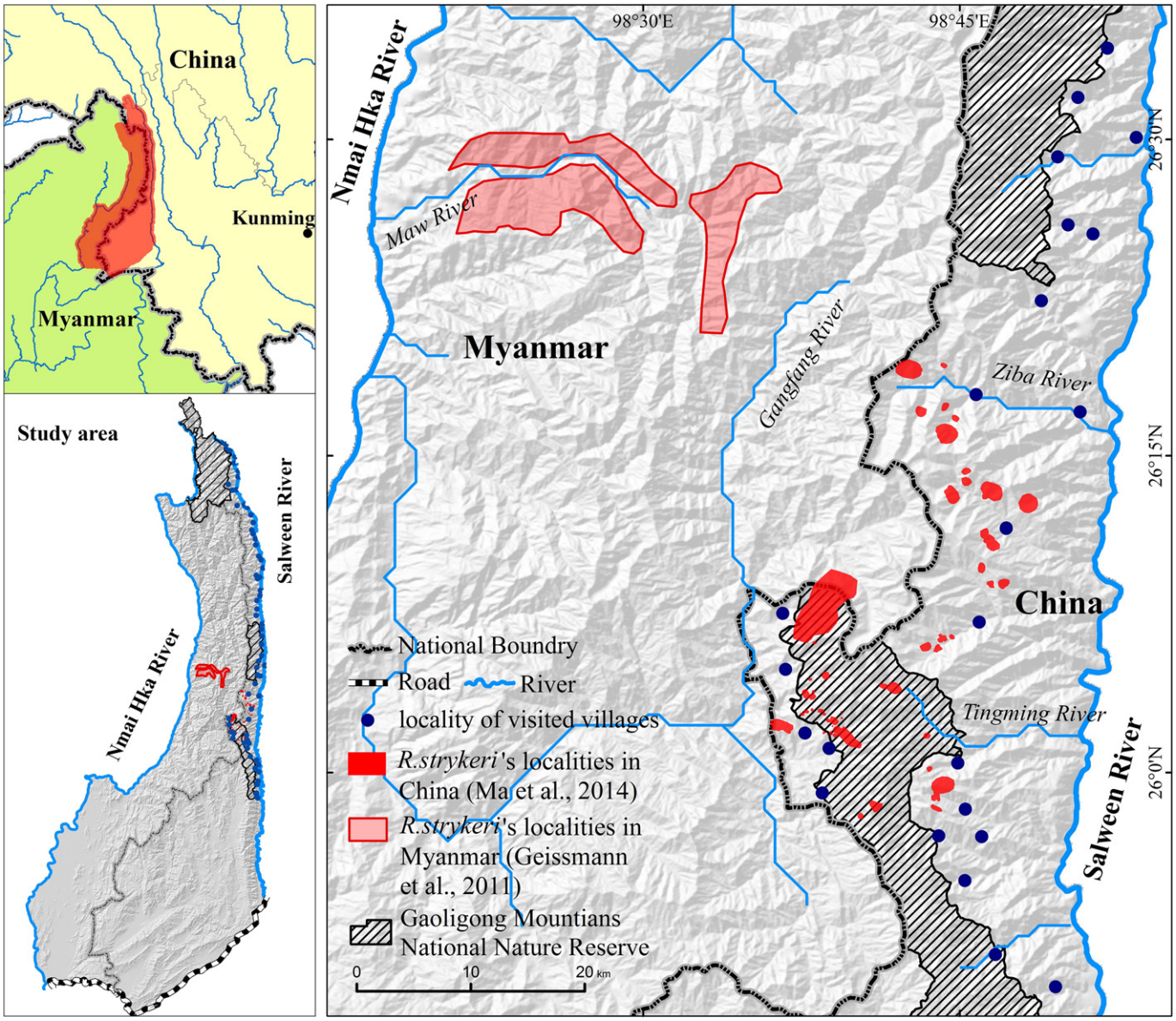

Fig. 1. Map of the study area and distribution of *R. strykeri* in the Sino-Myanmar border region.