CONSERVATION STATUS OF THE MYANMAR OR BLACK SNUB-NOSED MONKEY *RHINOPITHECUS STRYKERI*

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ABBREVIATIONS

AIMZ	Anthropological Institute and Museum of the University of Zurich
ANU	Australian National University
asl	above sea level
BANCA	Biodiversity and Nature Conservation Association
CERS	China Exploration and Research Society
CfN	Chances for Nature
CI	Conservation International
CPI	China Power Investment Corporation
CR	Critically Endangered
DPZ	German Primate Center
DU	Dali University
EN	Endangered
FD	Forest Department
FFI	Flora & Fauna International
IEHBR	Institute of Eastern-Himalaya Biodiversity Research
IUCN	International Union for Conservation of Nature
KIA	Kachin Independence Army
MMBF	Margot Marsh Biodiversity Foundation
MOECAF	Ministry of Environmental Conservation and Forestry
NGO	Non-governmental organization
NTFP	non-timber forest products
NWCD	Nature and Wildlife Conservation Division
PAF	Primate Action Plan
PRCF	People Resources and Conservation Foundation
VU	Vulnerable
USFWS	United States Fish and Wildlife Service
UWA	The University of Western Australia
YUFE	Yunnan Finance & Economy University
ZGAP	Zoological Society for the Conservation of Species and Populations

1 INTRODUCTION

1.1 Primate Classification

With more than 500 species and 700 taxa (species and subspecies), the primate order is one of the most diverse and successful mammalian orders (Groves 2001; Groves 2004; Fleagle 2013; Mittermeier et al. 2013; Rowe & Myers 2016). Primates originated sometimes in the Cretaceous (Perelman et al. 2011; Springer et al. 2012; Finstermeier et al. 2013; Pozzi et al. 2014) and over the course of their evolutionary history, they have developed not only an immense species diversity, but also a remarkable diversity in phenotype, behavior and adaptability (Smuts et al. 1987; Fleagle 2013).

Until the 1970s, the order of Primates contained - besides the taxa recognized as primates today - also tree shrews. However, genetic studies have clearly shown that flying lemurs (order Dermoptera) are closer related to primates than tree shrews, and thus the latter were classified in their own order Scandentia. “True” primates (taxa recognized as primates today) were originally divided into the suborders Prosimiae and Simiae. According to this classification, tarsiers, infraorder Tarsiiformes, were lumped together with lemurs, galagos, and lorises into Prosimiae, mainly on the basis of various shared primitive characters, while simiiform primates (New World monkeys, Old World monkeys, apes, and humans) were grouped into Simiae. Interestingly, tarsiers share some traits with the infraorder Simiiformes, so that they seem to occupy an intermediate position in the primate tree. Recent genetic studies convincingly have demonstrated that tarsiers indeed cluster with Simiiformes and not with lemurs, galagos and lorises. Consequently, primates are today correctly divided into the suborders Strepsirrhini (lemurs, galagos, and lorises) and Haplorrhini (Tarsiiformes and Simiiformes) (Roos & Zinner 2017). A brief overview of the classification of the order Primates down to family level is shown in Figure 1.

There is general agreement that Strepsirrhini initially split into Lemuriformes (Malagasy lemurs) and Lorisiformes (lorises and galagos). However, the lemur family Cheirogaleidae was sometimes suggested as a sister lineage to Lorisiformes, but genetic data confirmed the reciprocal monophyly of both infraorders. Among Lemuriformes, the family Daubentoniidae split off first, while the remaining four extant families, Cheirogaleidae, Lepilemuridae, Lemuridae and Indriidae, diverged during a geologically short time period. Due to the early divergence of Daubentoniidae, this family is sometimes classified in its own infraorder Chiromyiformes. Although Cheirogaleidae, Lepilemuridae, Lemuridae and Indriidae are suggested as sister families, the true branching pattern among these four families is still unknown and needs further investigation. Lorisiformes are traditionally divided into the two

families Galagidae and Lorisidae, but genetic evidence for the monophyly of Lorisidae is lacking. In fact, genetic data suggest a rapid radiation into three lineages: Galagidae, African Lorisidae and Asian Lorisidae.

Shortly after the split between Strepsirrhini and Haplorrhini, tarsiers separated from Simiiformes. The infraorder Simiiformes contains the two parvorders Platyrrhini (New World monkeys) and Catarrhini (Old World monkeys, apes, and humans). Among the former, traditionally only two families were recognized. The relatively small-sized New World monkeys with claws were grouped in the family Callitrichidae, while all other New World monkeys were combined in the family Cebidae. This classification, however, does not reflect the evolutionary history of platyrrhine primates, as cebids would then be paraphyletic. Today, there is consensus that New World monkeys contain five major lineages, most commonly referred to as families. The family Pitheciidae split off first, followed by Atelidae, before finally also Aotidae, Cebidae and Callitrichidae diverged. The phylogenetic relationships among the latter three families are still unresolved.

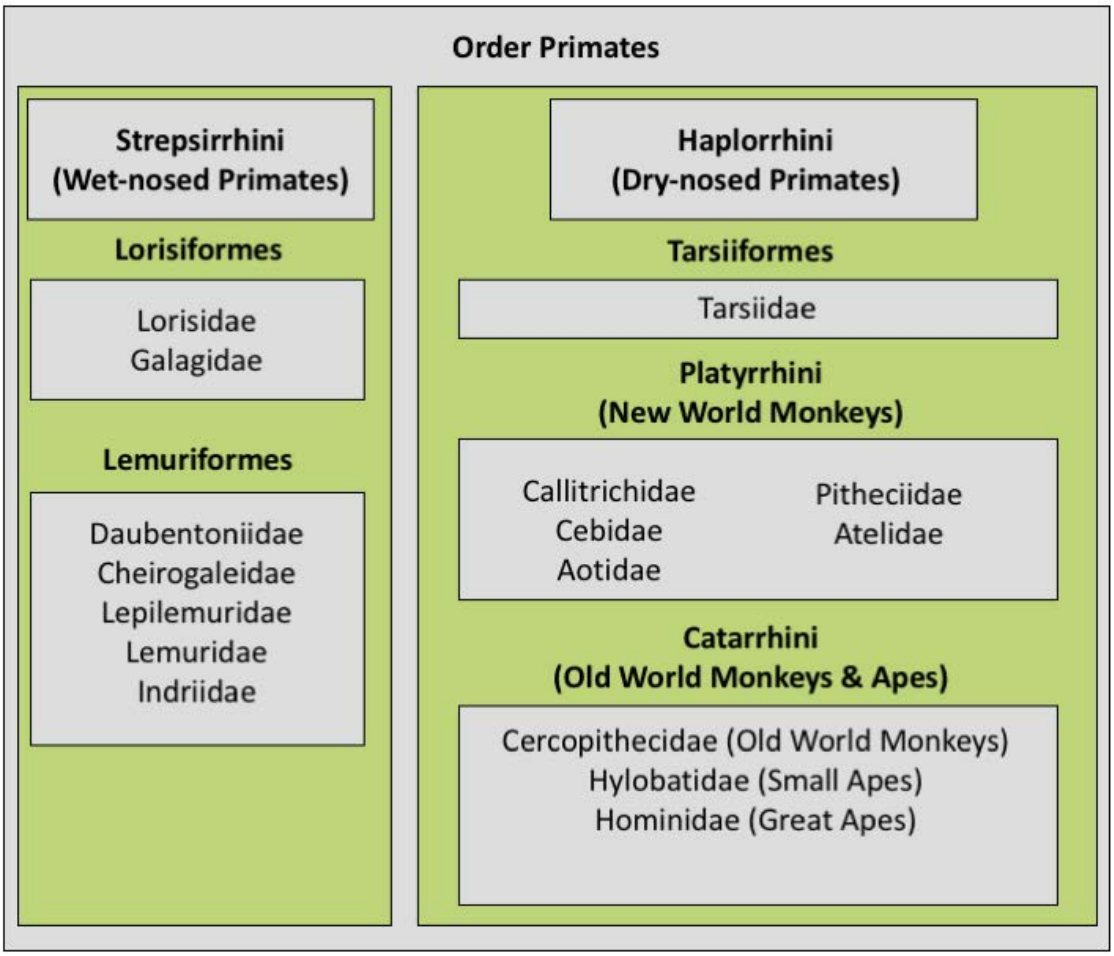

Figure 1. Overview of the classification of the order Primates down to family level.

The parvorder Catarrhini includes the two superfamilies Cercopithecoidea (Old World monkeys) and Hominoidea (apes and humans). In the former, extant representatives are subsumed in the family Cercopithecidae, the most speciose of all primate families. The family is further divided into the two subfamilies Cercopithecinae (cheek-pouched monkeys) and Colobinae (leaf-eating monkeys), and each of them contains two tribes (Cercopithecini and Papionini, and Colobini and Presbytini, respectively). The superfamily Hominoidea contains the two families Hylobatidae (small apes) and Hominidae (great apes and humans).

The Myanmar or black snub-nosed monkey is a species of the genus *Rhinopithecus* (snub-nosed monkeys), which is a member of the Asian Colobinae tribe Presbytini of the family Cercopithecidae.

1.2 Non-human Primates in Myanmar – an Overview

Myanmar is home to at least 18 non-human primate species, representing three primate families: the family Lorisidae of the primate suborder Strepsirrhini, and the families Cercopithecidae and Hylobatidae of the primate suborder Haplorrhini (Roos et al. 2014).

The **Bengal Slow Loris** (*Nycticebus bengalensis* [Lacépède 1800]) is the only species of the family Lorisidae in Myanmar, but due to its wide range it can be expected that this species might contain more than one taxon. With 13 species, the family Cercopithecidae is the most speciose in Myanmar. Among them are five macaque species of the Cercopithecidae subfamily Cercopithecinae and eight species of the Cercopithecidae subfamily Colobinae. The five macaque species are: (1) **Northern Pig-tailed Macaque** (*Macaca leonina* [Blyth 1863]), (2) **Assamese Macaque** (*Macaca assamensis* [McClelland 1839]), (3) **Stump-tailed Macaque** (*Macaca arctoides* [I. Geoffroy Saint-Hilaire 1831]), (4) **Long-tailed Macaque** (*Macaca fascicularis* [Raffles 1821]), and (5) **Rhesus Macaque** (*Macaca mulatta* [Zimmermann 1780]). The eight colobine species are (1) **Banded Langur** (*Presbytis femoralis* [Martin 1838]), (2) **Capped Langur** (*Trachypithecus pileatus* [Blyth 1843]), (3) **Shortridge's Langur** (*Trachypithecus shortridgei* [Wroughton 1915]), (4) **Dusky Langur** (*Trachypithecus obscurus* [Reid 1837]), (5) **Phayre's Langur** (*Trachypithecus phayrei* [Blyth 1847]), (6) **Tenasserim Langur** (*Trachypithecus barbei* [Blyth 1847]), (7) **Indochinese Grey Langur** (*Trachypithecus crepusculus* [Elliot 1909]), and (8) **Myanmar or Black Snub-nosed Monkey** (*Rhinopithecus strykeri* Geissmann et al. 2011). The **Germain's Langur** (*Trachypithecus germaini* [Milne-Edwards 1876]), sometimes also listed for Myanmar (Groves 2001; Anandam et al. 2013; Rowe & Myers 2016), is most likely not present in the country. The putative occurrence of the species in Myanmar is based on the wrong assignment of *Pithecus pyrrhus atrior* (Pocock 1928) as a synonym of *T. germaini* instead of *T. barbei* (Geissmann et al. 2004; Roos unpublished). The

family Hylobatidae in Myanmar is represented by four species: (1) **Western Hoolock Gibbon** (*Hoolock hoolock* [Harlan 1834]), (2) **Eastern Hoolock Gibbon** (*Hoolock leuconedys* [Groves 1967]), (3) **Gaoligong** or **Skywalker Hoolock Gibbon** (*Hoolock tianxing* Fan et al. 2017), and (4) **White-handed Gibbon** (*Hylobates lar* [Linnaeus 1771]) (Mittermeier et al. 2013; Roos et al. 2014; Rowe & Myers 2016; Fan et al. 2017). The **Siamang** (*Symphalangus syndactylus* [Raffles 1821]) was also listed for Myanmar (Helfer 1838), but no modern firsthand confirmation for its presence in the country is available.

1.3 Non-human Primates in China – an Overview

China is home to 26-29 non-human primate species, representing three primate families: the family Lorisidae of the primate suborder Strepsirrhini, and the families Cercopithecidae and Hylobatidae of the primate suborder Haplorrhini (Roos et al. 2014).

The **Bengal Slow Loris** (*Nycticebus bengalensis* [Lacépède 1800]) is probably the only species of the family Lorisidae in China. The occurrence of the **Pygmy Slow Loris** (*Nycticebus pygmaeus* Bonhote 1907) is uncertain and species records for China may be based on released captives brought in from elsewhere (Roos et al. 2014). With 17-18 species, the family Cercopithecidae is the most speciose in China. Among them are eight macaque species of the Cercopithecidae subfamily Cercopithecinae and ten to eleven species of the Cercopithecidae subfamily Colobinae. The eight macaque species are: (1) **Northern Pig-tailed Macaque** (*Macaca leonina* [Blyth 1863]), (2) **Assamese Macaque** (*Macaca assamensis* [McClelland 1839]), (3) **Tibetan Macaque** (*Macaca thibetana* [Milne-Edwards 1870]), (4) **White-cheeked Macaque** (*Macaca leucogenys* Li et al. 2015), (5) **Arunachal Macaque** (M*acaca munzala* Sinha et al. 2005), (6) **Stump-tailed Macaque** (*Macaca arctoides* [I. Geoffroy Saint-Hilaire 1831]), (7) **Rhesus Macaque** (*Macaca mulatta* [Zimmermann 1780]), and (8) **Taiwanese Macaque** (*Macaca cyclopis* [Swinhoe 1863]) (Mittermeier et al. 2013; Roos et al. 2014; Li et al. 2015; Rowe & Myers 2016). The ten confirmed colobine species are: (1) **Shortridge's Langur** (*Trachypithecus shortridgei* [Wroughton 1915]), (2) **Phayre's Langur** (*Trachypithecus phayrei* [Blyth 1847]), (3) **Indochinese Grey Langur** (*Trachypithecus crepusculus* [Elliot 1909]), (4) **Francois' Langur** (*Trachypithecus francoisi* [Pousarges 1098]), (5) **White-headed Langur** (*Trachypithecus leucocephalus* Tan 1957), (6) **Central Himalayan Sacred Langur** (*Semnopithecus schistaceus* Hodgson 1940), (7) **Golden Snub-nosed Monkey** (*Rhinopithecus roxellana* [Milne Edwards 1970]), (8) **Yunnan Snub-nosed Monkey** (*Rhinopithecus bieti* Milne Edwards 1897), (9) **Guizhou Snub-nosed Monkey** (*Rhinopithecus brelichi* Thomas 1903), and (10) **Myanmar or Black Snub-nosed Monkey** (*Rhinopithecus strykeri* Geissmann et al. 2011) (Mittermeier et al. 2013; Roos et al. 2014; Rowe & Myers 2016). The occurrence of

the **Tonkin Snub-nosed Monkey** (*Rhinopithecus avunculus* Dollmann 1912) in China is not confirmed yet, but the species' occurrence in the border region to Vietnam is highly likely (Roos et al. 2014). The family Hylobatidae in China is represented by seven to eight species: (1) **Eastern Hoolock Gibbon** (*Hoolock leuconedys* [Groves 1967]), (2) **Gaoligong** or **Skywalker Hoolock Gibbon** (*Hoolock tianxing* Fan et al. 2017), (3) **White-handed Gibbon** (*Hylobates lar* [Linnaeus 1771]) (probably now extinct in China), (4) **Hainan Crested Gibbon** (*Nomascus hainanus* [Thomas 1892]), (5**) Eastern Black Crested Gibbon** (*Nomascus nasutus* [Milne-Edwards 1884]), (6) **Western Black Crested Gibbon** (*Nomascus concolor* [Harlan 1826]), and (7) **Northern White-cheeked Crested Gibbon** (*Nomascus leucogenys* [Ogilby 1841]) (Mittermeier et al. 2013; Roos et al. 2014; Rowe & Myers 2016; Fan et al. 2017). The occurrence of the **Western Hoolock Gibbon** (*Hoolock hoolock* [Harlan 1834]) in China is not confirmed (Roos et al. 2014).

1.4 An Introduction to Colobine Monkeys (Subfamily Colobinae)

Extant colobine monkeys are mainly found in the tropical belt of Africa and throughout most of South and South-East Asia with a higher diversity in Asia (7 genera, 55 species) than in Africa (3 genera, 23 species) (Anandam et al. 2013; Zinner et al. 2013). Based on geographical distribution and morphological features colobines have been divided into an African (Colobini) and Asian (Semnopithecini or Presbytini) group (Delson 1975; Groves 2001). Asian colobines are further divided into the langur (*Semnopithecus, Trachypithecus, Presbytis*) and odd-nosed monkey group (*Simias, Nasalis, Pygathrix, Rhinopithecus*) (Figure 2) (Jablonski 1998; Groves 2001; Roos et al. 2011; Zinner et al. 2013).

African and Asian groups have been suggested to form reciprocally monophyletic groups (Napier & Napier 1967; Oates et al. 1994; Groves 2001), but recent genetic data question this division (Roos et al. 2011). Further, for Asian colobines, the monophyly of the odd-nosed monkey group is strongly supported by genetic data (Roos et al. 2011; Liedigk et al. 2012), but the langur group is suggested to be paraphyletic (Sterner et al. 2006; Ting et al. 2008; Roos et al. 2011; Wang et al. 2012; Roos et al. in press).

Colobine monkeys most likely evolved in Africa in the Early Miocene, 18-16 million years ago (Perelman et al. 2011; Roos et al. 2011). The progenitor of Asian colobines diverged from African colobines 12-10 million years ago and subsequently invaded Eurasia (Goodman et al. 1998; Raaum et al. 2005; Sterner et al. 2006; Roos et al. 2011; Liedigk et al. 2012). The Asian colobine ancestor most likely colonized Eurasia via an emerging land bridge connecting Africa and the Arabian Peninsula and subsequently migrated further east (Whybrow 1992; Stewart & Disotell 1998). After their arrival in Asia, colobine monkeys diverged ca. 8-10 million years ago into three lineages, *Semnopithecus*, *Trachypithecus/Presbytis* and the odd-nosed monkey group

(Roos et al. 2011; Roos et al. in press). This event most likely occurred in southwestern China, probably in the Hengduan Mountain range in the border region of today's Myanmar, India and China (Peng et al. 1993; Jablonski 1998; Roos et al. 2011). During the Miocene, this region was affected by major geographical changes, for instance regional tectonic uplift and subsidence related to the orogeny of the Himalayan Mountain range (An et al. 2001) and the emergence of the large South-East Asian rivers (Mekong, Salween, Yangtze) (Hallet & Molar 2001). These geographical changes might have resulted in a series of vicariance events that gave rise to the diversification of Asian colobine lineages during the Late Miocene. Further support for this region as "cradle" of Asian colobines is provided by the recent discovery of a fossil colobine belonging to the genus *Mesopithecus* in northeastern Yunnan Province, near Zhaotong that seems to be a stem colobine (Jablonski et al. 2011). Subsequently, *Semnopithecus* invaded the Indian subcontinent, while the progenitor of *Trachypithecus*/*Presbytis* colonized the South-East Asian mainland and the progenitor of the odd-nosed monkeys the region of today's China. After *Trachypithecus* and *Presbytis* had diverged, the former came into secondary contact with *Semnopithecus* and hybridized with them. In the odd-nosed monkey group, *Rhinopithecus* diverged, followed by *Pygathrix*, before finally *Nasalis* and *Simias* separated (Roos et al. 2011; Liedigk et al. 2012; Roos et al. in press). Accordingly, a clear North-to-South migration becomes obvious in the odd-nosed monkey group that started 7-5 million years ago and ended with the split between *Nasalis* and *Simias* 2-1 million years ago (Roos et al. 2011; Liedigk et al. 2012; Roos et al. in press).

Colobine monkeys are medium-sized primates. With the exception of *Nasalis* and *Rhinopithecus*, all other colobines exhibit only slight sexual dimorphism in body size. Their head-body-length ranges from 46 to 83 cm in males and from 38 to 83 cm in females. The tail has a length of 50 to 104 cm in males (in *Simas* ~16 cm) and 42 to 96 cm in females (in *Simias* ~14 cm). Body mass ranges from 4 to 24 kg in males (in *Rhinopithecus* occasionally 39 kg) and 3 to 12 kg in females (in *Rhinopithecus* occasionally 20 kg) (Anandam et al. 2013).

They predominantly eat leaves and unripe fruits and hence have developed a ruminant-like multi-chambered stomach and a complex foregut in which microbes ferment otherwise indigestible plant material such as cellulose (Napier & Napier 1967; Chivers & Hladik 1980; Oates & Davies 1994). Other key anatomical characters related to food processing are greatly enlarged salivary glands (Oates & Davies 1994) and sharp molars to chew leaves (Lucas et al. 1994).

Although colobine monkeys are highly folivorous than other primates, their diet varies across species (Struhsaker & Leland 1987). In general, African colobines are more folivorious (leaves can make up to 92% of their diet) than Asian colobines, but all species exhibit considerable dietary flexibility and can also feed on fruits, seeds, flowers, buds, bark, lichens, invertebrates

and some small vertebrates (Zinner et al. 2013). Some colobine species eat parts of more than 100 plant species and diet composition can also vary substantially among seasons. Although young leaves are preferred, colobine monkeys consume also mature leaves when young leaves are not available. Some colobines eat also fruits, mainly unripe, since ripe fruits might be too acidic, thus killing the beneficial symbiotic microorganisms in the stomach. In general, leaf quality and the ratio of protein to fiber in plant items seem to influence the abundance of colobine monkeys (Davies 1994; Chapman & Chapman 2002).

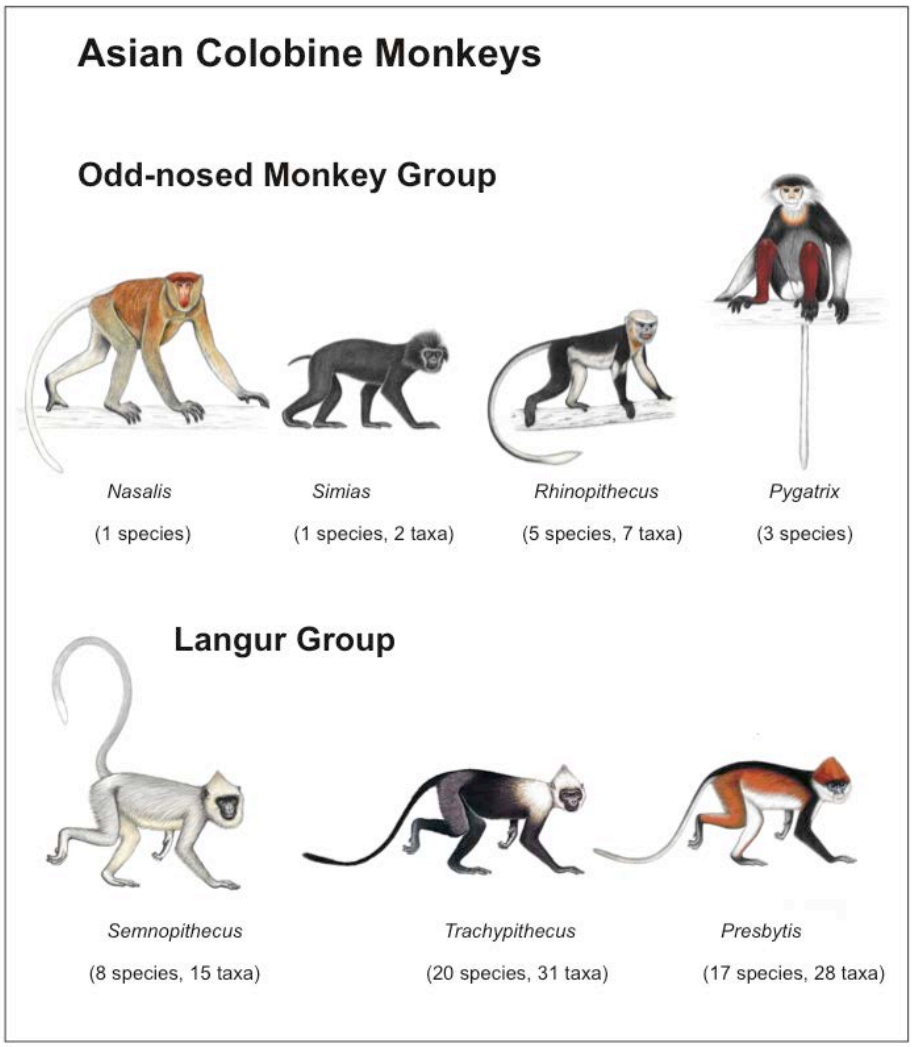

Figure 2. Representatives of the seven Asian colobine monkey genera. Numbers of species, and species and subspecies (taxa) based on Mittermeier et al. (2013) and Roos et al. (2014). Primate drawings by Stephan Nash, Conservation International.

Likewise, colobine monkeys display a great diversity in social organization. Reported are female-philopatric–one-male units (e.g. *Colobus guereza*, *Trachypithecus obscurus*, *Presbytis melalophos*, *Nasalis larvatus*, *Semnopithecus entellus*), female-philopatric–multi-male societies (e.g. *Colobus satanas*, *Nasalis larvatus*, *Semnopithecus entellus*), male-philopatric–multi-male-

multi-female societies (e.g. *Piliocolobus badius*, *Procolobus verus*), one-male units with bisexual dispersal (e.g. *Presbytis thomasi* (Sterck et al. 2005) and even monogamy (e.g. *Presbytis potenziani*) (Tilson 1976; Watanabe 1981; Newton & Dunbar 1994). Monogamy, however, are most likely the result of excessive hunting and habitat disturbance that reduce group size (Watanabe 1981; Erb et al. 2002). Males outside female-male units often form all-male groups (Struhsaker & Leland 1987). Some colobines such as snub-nosed monkeys (*Rhinopithecus* spp.) or proboscis monkeys (*Nasalis larvatus*) tend to form multilevel, nested, or modular societies, which are structurally characterized by one-male units and all-male groups embedded within larger relatively coherent social bands (Grueter & Zinner 2004; Grueter & van Schaik 2009; Kirkpatrick & Grueter 2010; Grueter et al. 2012). While the social organization of snub-nosed monkeys conforms to this multilevel pattern with one-male units at its core, the mating system of at least some populations appears to be polygynandrous, as evidenced by frequent extra-pair copulations (Guo et al. 2010; Qi et al. in prep.).

Further variations in features like flamboyant natal coats and sexual swellings or variations in aspects of colobine social behavior, such as grooming patterns, nurturing behavior and infanticide are probably also linked to this variation in social organization (Clutton Brock & Harvey 1977; Newton & Dunbar 1994).

Although colobine monkeys constitute a diverse subfamily within the Old World monkey family Cercopithecidae, they have attracted relatively little scientific attention over the past decades in contrast to their sister subfamily, the Cercopithecinae. Although more work was conducted on them in recent years, colobine monkeys continue to be one of the most enigmatic primate groups, and much of their ecology, behavior and phylogenetic relatedness is still poorly understood. Thus, more scientific and public attention as well as conservation actions are urgently needed to safeguard their survival. Asian colobine monkeys are threatened by extinction with 75% of species classified as Vulnerable (VU; 9 species), Endangered (EN; 23 species) or Critically Endangered (CR; 9 species) (Roos et al. 2014; Estrada et al. 2017). As a result, several of these species have been frequently listed among the 25 Most Endangered Primates of the World (Mittermeier et al. 2006; Mittermeier et al. 2007; Mittermeier et al. 2009; Mittermeier et al. 2012; Mittermeier et al. 2014).

1.5 An Introduction to Snub-nosed Monkeys (Genus *Rhinopithecus*)

The genus *Rhinopithecus* is one of the four genera in the odd-nosed monkey group. The name odd-nosed monkeys derived from the unusual nose morphology of the group members *Rhinopithecus* (snub-nosed monkeys), *Pygathrix* (doucs), *Simias* (simakobu or pig-tailed langur) and *Nasalis* (proboscis monkey). The genus *Rhinopithecus* is restricted to China,

Vietnam and Myanmar, and comprises five allopatric species (Figure 3) that are classified as either Endangered (EN) or Critically Endangered (CR) (Mittermeier et al. 2013; Roos et al. 2014). The five species, along with their conservation status and geographical distribution (see also Figure 4), are:

Golden Snub-nosed Monkey: *R. roxellana* (Milne-Edwards 1870) (EN)
West Central China

Moupin Golden Snub-nosed Monkey: *R. r. roxellana* (Milne-Edwards 1870) (EN)
South Gansu, South Shaanxi, and West Sichuan provinces

Hubei Golden Snub-nosed Monkey: *R. r. hubeiensis* Wang et al. 1998 (EN)
Shennongjia in West Hubei Province and North-East Sichuan Province

Qinling Golden Snub-noses Monkey: *R. r. qinlingensis* Wang et al. 1998 (EN)
Qinling Mountains, South Shaanxi Province

Yunnan Snub-nosed Monkey: *R. bieti* Milne-Edwards 1897 (EN)
South-West China, in South-East Xizang Autonomous Region [= Tibet] and North-West Yunnan Province (fragmented populations in the Yunling Mountains), West of Yangtze River and East of Mekong River

Guizhou Snub-nosed Monkey: *R. brelichi* Thomas 1903 (EN)
South Central China, Guizhou Province, Fanjingshan in the Wuling Mountains

Tonkin Snub-nosed Monkey: *R. avunculus* Dollman 1912 (CR)
North-West Vietnam, known only from small forest patches in Ha Giang, Tuyen Quang, Bac Kan, and Thai Nguyen provinces; probably also in neighboring China

Myanmar or Black Snub-nosed Monkey: *R. strykeri* Geissmann et al. 2011 (CR)
Border region between Myanmar and China between N'mai Hka River and Salween River in Kachin State, North-East Myanmar and North-West Yunnan Province, China

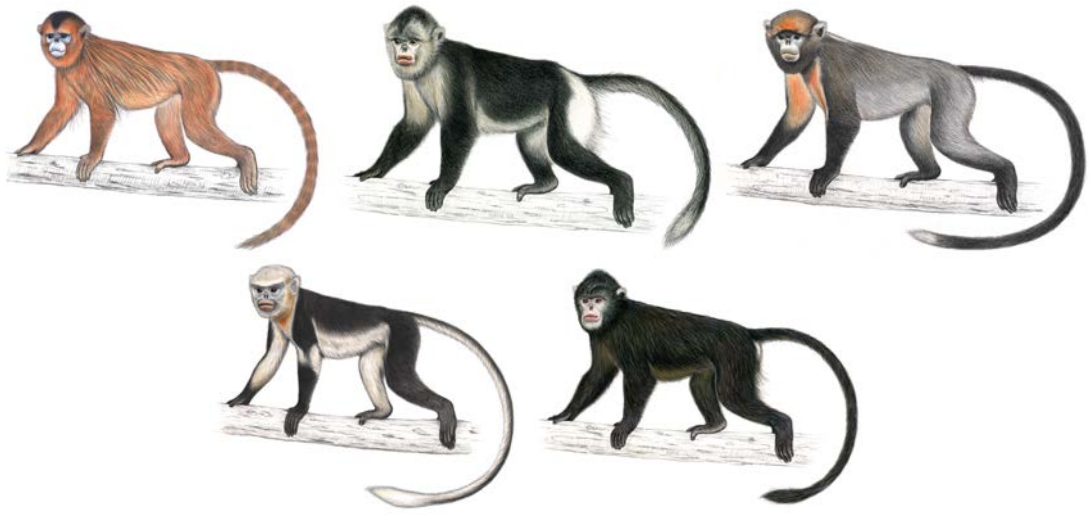

Figure 3. Drawings of the five snub-nosed monkey species. Top row: *R. roxellana* (left), *R. bieti* (middle), *R. brelichi* (right); bottom row: *R. avunculus* (left), *R. strykeri* (right). Drawings by Stephan Nash, Conservation International.

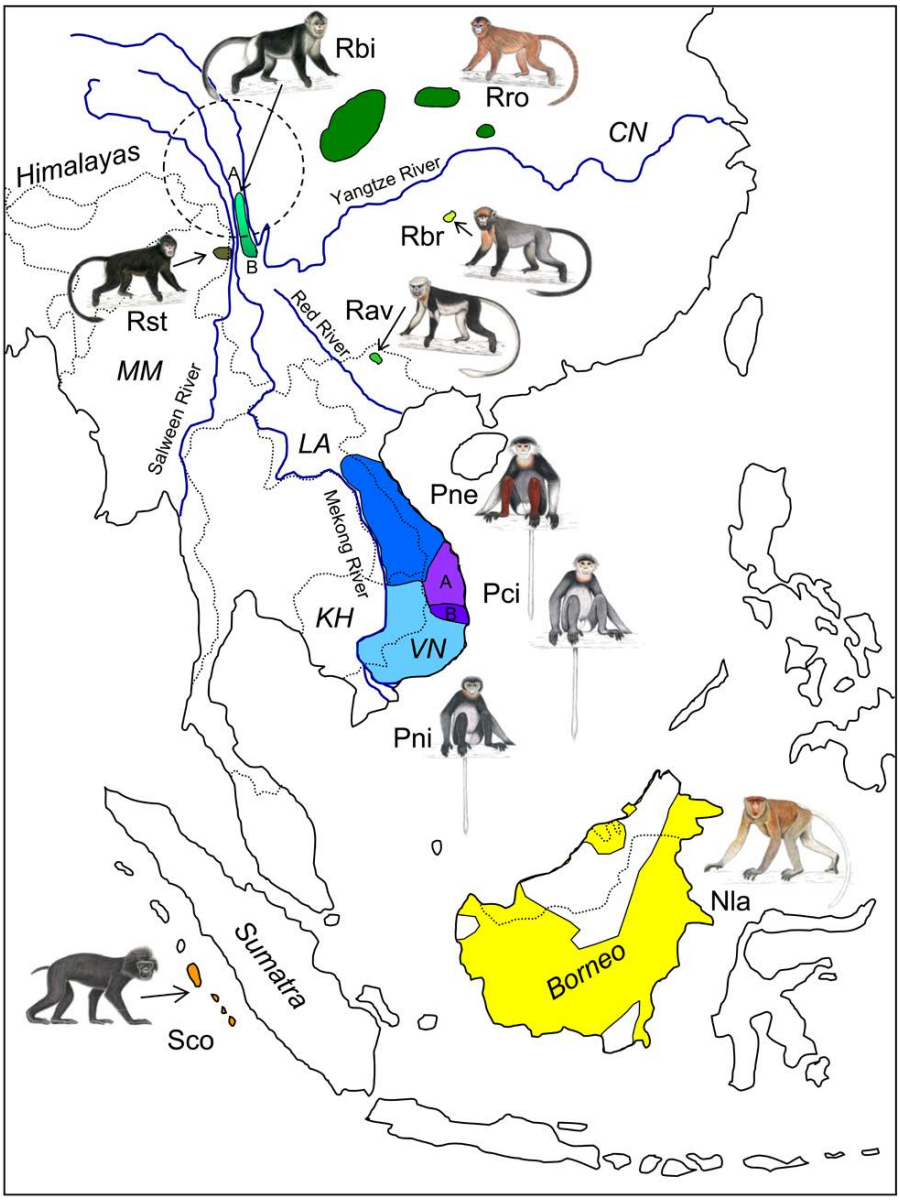

Figure 4. Geographical distribution of the odd-nosed monkeys (adapted from Liedigk et al. [2012]). Hatched and blue lines indicate country borders and major rivers, respectively. The Hengduan Mountain range as presumed center of origin is depicted as dashed circle. Abbreviations in the figure are: Rro = *R. roxellana*, Rbi = *R. bieti*, Rst = *R. strykeri*, Rbr = *R. brelichi*, Rav = *R. avunculus*, Pne = *Pygathrix nemaeus*, Pci = *Pygathrix cinerea*, Pni = *Pygathrix nigripes*, Sco = *Simias concolor*, and Nla = *Nasalis larvatus*, CN = China, KH = Cambodia, LA = Laos, MM = Myanmar, VN = Vietnam. A and B refer to the distribution of main haplogroups found in *R. bieti* and *P. cinerea*, respectively. Primate drawings by Stephen Nash, Conservation International.

Snub-nosed monkeys exhibit a complex evolutionary history with various cases of secondary gene flow among populations and species (Figures 5 & 6) (Liedigk et al. 2012). According to Liedigk et al. (2012), *R. avunculus* diverged first, ~2.4 million years ago, followed by the split of the progenitor of the Himalayan species (*R. bieti, R. strykeri*) and the northern species (*R. roxellana, R. brelichi*), ~2 million years ago. The latter divided into respective species 1.8-1.3 million years ago. These two species remained separated since then. *R. avunculus* came later

into secondary contact with the progenitor of the Himalayan species; gene flow among them occurred until ~0.7 million years ago. The progenitor of the latter originally split into three lineages (*R. bieti* haplogroup A, *R. bieti* haplogroup B, *R. strykeri*), ~0.60-0.24 million years ago. The *R. bieti* haplogroup B occurs mainly in the southern part of the species' range (Liu et al. 2007a) and is closer related to *R. strykeri* than to *R. bieti* haplogroup A (Liedigk et al. 2012). After the split of *R. strykeri* 0.24 million years ago, both *R. bieti* haplogroups came into contact again and homogenized their nuclear gene pools (Liu et al. 2009). Today, both mitochondrial haplogroups of *R. bieti* intergrade, although there is still a trend of a northern and southern clade (Liu et al. 2007a). Recent analysis using whole genome sequence data confirm the close affiliation between the northern forms (*R. roxellana, R. brelichi*) and the Himalayan species (*R. bieti, R. strykeri*) and further provide evidence for introgressive hybridization between various snub-nosed monkey lineages (Zhou et al. 2014).

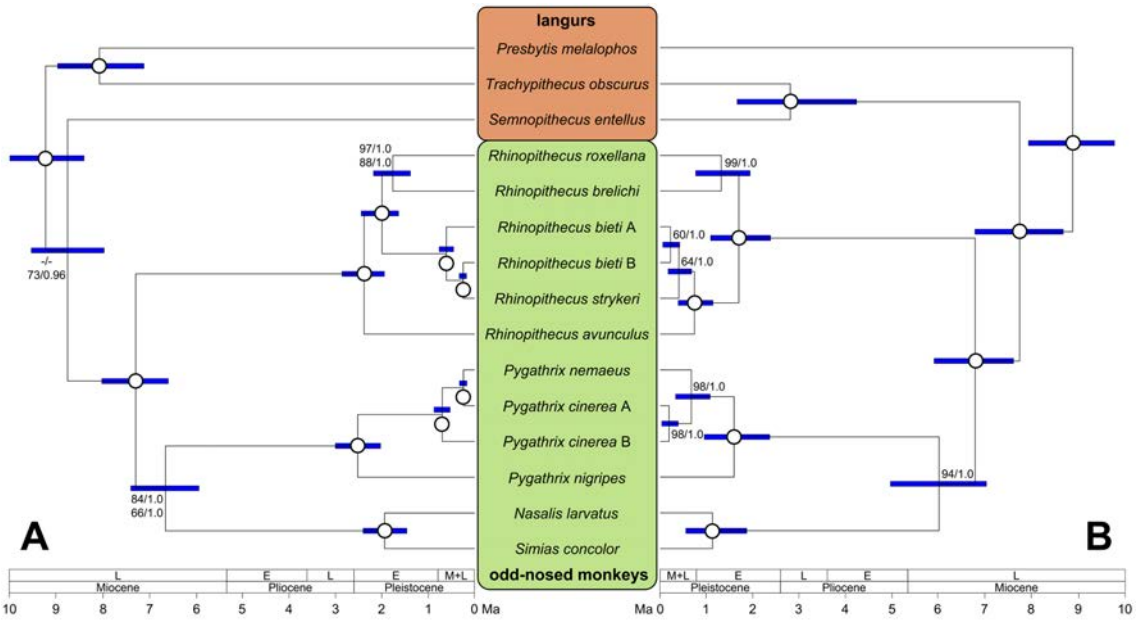

Figure 5. Ultrametric tree showing phylogenetic relationships among Asian colobines as obtained from mitochondrial (A) and nuclear sequence data (B). Open circles indicate maximum-likelihood bootstrap values (BS) of 100% and Bayesian posterior probabilities of 1.0; values below are given at respective branches. Blue bars represent 95% highest posterior densities of divergence ages. In A, upper and lower numbers on branches indicate maximum-likelihood bootstrap values and Bayesian posterior probabilities as derived from different mitochondrial datasets. Abbreviations used in the bars: L = late, E = early, and M= middle. Adapted from (Liedigk et al. 2012).

Members of the genus *Rhinopithecus* are characterized by up-turned noses, large, prominent lips and naked skin around the eyes (Groves 1970; Kirkpatrick & Grueter 2010). Snub-nosed monkeys are comparatively large colobines and exhibit a prominent sexual dimorphism in canine size (Jablonski & Ruliang 1995) and body mass (Grueter & van Schaik 2009), with a

female body mass up to 9 kg and a male body mass up to 17 kg, sometimes even up to 39 kg (Kirkpatrick 1998; Anandam et al. 2013; Zhu et al. 2015).

Snub-nosed monkeys inhabit a variety of habitats at elevations between 200 m asl (*R. avunculus*) and 4400 m asl (*R. bieti*) (Kirkpatrick & Grueter 2010). Habitat types used by snub-nosed monkeys include evergreen and deciduous subtropical broadleaf forests, bamboo forest patches, tropical evergreen broadleaf forests, temperate evergreen mountain forest, mixed deciduous forest and coniferous forests (Bleisch et al. 1993; Jablonski 1998; Ren et al. 1998; Li et al. 2008; Kirkpatrick & Grueter 2010; Zinner et al. 2013). These gradients of forest and climate are fundamental to adaptive arrays in diet, social organization and range use in the genus (Kirkpatrick & Grueter 2010).

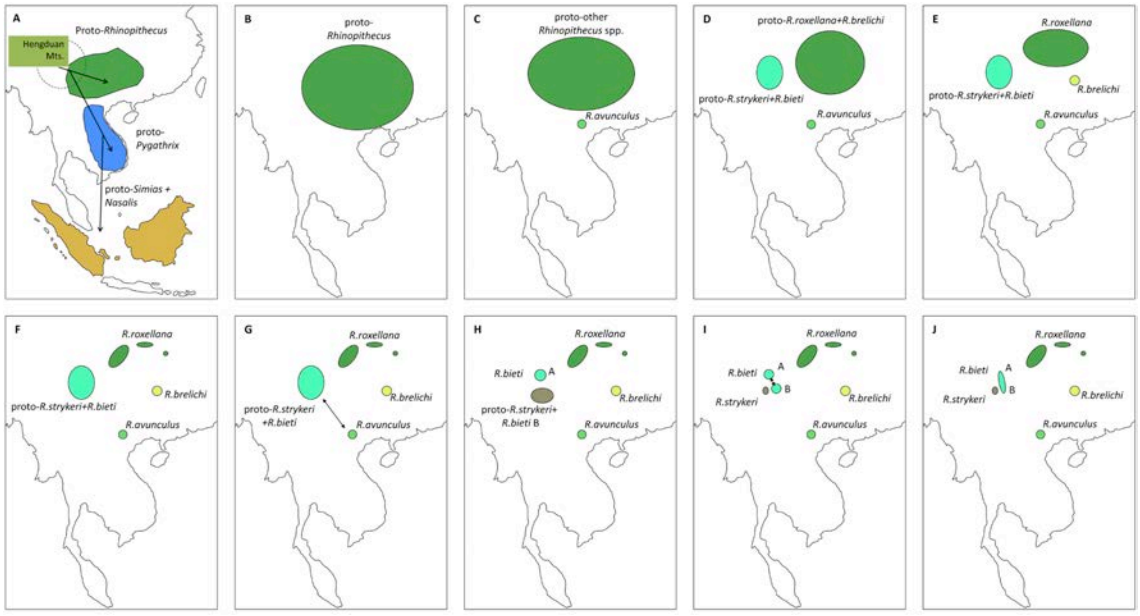

Figure 6. Proposed dispersal scenario for odd-nosed monkeys and specifically for snub-nosed monkeys. (A) Odd-nosed monkeys most likely originated in the Hengduan Mountain range on the Asian mainland and migrated successively into Indochina and Sundaland during the late Miocene. In *Rhinopithecus* (B-J), differentiation into species started in the early Pleistocene, but secondary gene flow among various lineages occurred until the middle Pleistocene (indicated as arrows). A and B refer to the distribution of main haplogroups of *R. bieti*. Adapted from Liedigk et al. (2012).

Most snub-nosed monkey species are predominantly folivorous, but fruits, seeds, bark, flowers, buds, stems and even lichens are also important components of their diet. The proportion of certain diet components differs between species and season (Bleisch et al. 1993; Jablonski 1998; Ren et al. 1998; Kirkpatrick et al. 1999; Kirkpatrick et al. 2001; Ding & Zhao 2004; Guo et al. 2007; Quyet et al. 2007; Xiang et al. 2007; Grueter et al. 2009a; Grueter et al. 2009b; Grueter et al. 2010; Li et al. 2010). Eating lichens (*R. roxellana, R. bieti*) is a striking dietary adaptation which is unusual for colobines and primates in general (Kirkpatrick & Grueter 2010).

As in many other colobines, basic social groupings in snub-nosed monkeys are one-male–multi-female units and all-male units (Bleisch & Xie 1998; Boonratana & Canh 1998; Ren et al. 1998; Kirkpatrick & Grueter 2010). Multi-male–multi-female units are also reported but are rare (Ren et al. 1998; Kirkpatrick et al. 1999; Liu et al. 2007b; Kirkpatrick & Grueter 2010). Group sizes range from 3-10 individuals to more than 400 individuals in modular societies which are structurally characterized by one-male and all-male units embedded within larger relatively coherent social bands (Grueter & Zinner 2004; Grueter & van Schaik 2009; Kirkpatrick & Grueter 2010; Grueter et al. 2012; Grueter 2013; Chen et al. 2015). This complex social system is only reported in a small number of mammalian species (Grueter et al. 2012; Qi et al. 2014). Phylogenetic and social factors might have played an important role in the origin and evolution of modular societies (Grueter & van Schaik 2010; Grueter et al. 2012) and the complex social system of *Rhinopithecus* is suggested to have evolved by the aggregation of separate one-male–multi-female units from an ancestral Asian colobine into a larger, more cohesive breeding band (Grueter & van Schaik 2009; Qi et al. 2014).

The average age at first reproduction of females range from 5-6 years (*R. roxellana* and *R. bieti*) to 8-9 years (*R. brelichi*) (Ji et al. 1998; Liang et al. 2000a; Liang et al. 2000b; Qi et al. 2008; Yang et al. 2009). Snub-nosed monkey males start reproducing with 6.5-7 years (Liang et al. 2000b; Zou 2002; Cui et al. 2008).

In contrast to most other colobines, where home range sizes often do not exceed 10 km^2, *Rhinopithecus* groups/bands have large home range sizes between 16 km^2 and 40 km^2 which are at least partly due to large group size (Kirkpatrick et al. 1998; Li et al. 2000; Tan et al. 2007; Grueter et al. 2008; Xiang et al. 2013; Chen et al. 2015).

2 THE MYANMAR OR BLACK SNUB-NOSED MONKEY

2.1 Classification of the Myanmar or Black Snub-nosed Monkey

Order Primates Linnaeus 1758

Superfamily Cercopithecoidea Gray 1821

Family Cercopithecidae Gray 1821

Subfamily Colobinae Jerdon 1867

Genus *Rhinopithecus* Milne-Edwards 1872

Species *Rhinopithecus strykeri* Geissmann et al. 2011

2.2 An Introduction to the Myanmar or Black Snub-nosed Monkey

The Myanmar or black snub-nosed monkey (*Rhinopithecus strykeri*) was discovered in Myanmar in 2010 by a team of Flora & Fauna International (FFI) and the Biodiversity and Nature Conservation Association (BANCA), and described as new species the year after (Geissmann et al. 2011). Originally, the common name of the species was Burmese snub-nosed monkey, but later changed to Myanmar snub-nosed monkey. In China, the species is called Nujiang snub-nosed monkey or black snub-nosed monkey. The latter name is sometimes also given to the Yunnan snub-nosed monkey (*R. bieti*).

The fur coloration of *R. strykeri* is mainly black and blackish brown. The face is mostly naked with pale pink skin. *R. strykeri* has a prominent white chin beard. The freshly dead holotype (Figure 7) had a head-body-length of 55.5 cm and a tail length of 78 cm. The tail is black and the length is ca. 140% of the head-body length. Young individuals are much paler with more whitish hair (Geissmann et al. 2011) (see also Figure 18).

Compared to its congenerics, *R. strykeri* lacks the white underparts and white thigh backs of *R. bieti*, the white underparts and white circum-facial hair of *R. brelichi*, the yellowish-orange body fur and the skin flaps on the lateral upper lip of males of *R. roxellana*, and the bright gingery red fur coloration on underside and inner side of limbs of *R. brelichi*. *R. strykeri* shows similarities with *R. bieti* in the presence of a distinct, forward-swept occipital crest in adult males, and white ear tufts that sharply contrast with the black surrounding fur (Geissmann et al. 2011).

The skull (with mandible) and the skin of the holotype (AIMZ 15504.a and 15504.b, respectively) (Figures 7 & 8) have been deposited in the Anthropological Institute and Museum of the University of Zurich (AIMZ), Switzerland (Geissmann et al. 2011). As paratypes two

additional skulls from adults and a bag made from the skin of a juvenile have also been collected. The female skull has been deposited in AIMZ (AIMZ 15505), while the male skull (BANCA 2010.6) and bag (BANCA 2010.4) have been deposited in the zoological collection of Hlawga Wildlife Park, Yangon Division, Myanmar (Geissmann et al. 2011).

Figure 7. Freshly dead male holotype of *R. strykeri* in Pade village. Photo: Ngwe Lwin, taken on March 7, 2010.

In 2011 and 2012, an additional population was discovered (C8; Figure 9) in China approximately 50 km southeast of the site originally reported by Geissmann and colleagues (Long et al. 2012). Subsequently further sites in the Gaoligong Mountains (North-West Yunnan, China) have been described (Ma et al. 2014; Yang et al. 2016). Two skins have been collected in China and deposited at Dali University (DU), Yunnan, China (W. Xiao, pers. com.). In November 2017, two females, previously kept as pets in local villages, were held at the rescue center of Gaoligong Mountains National Nature Reserve in Pianma County, Nujiang Prefecture, Yunnan.

The phylogenetic position of *R. strykeri* (Liedigk et al. 2012; Zhou et al. 2014) suggests that the species is most likely similar to *R. bieti* in general biology and ecology, but detailed information is lacking. Likewise, the exact distribution and population size of the species is unknown and requires further research.

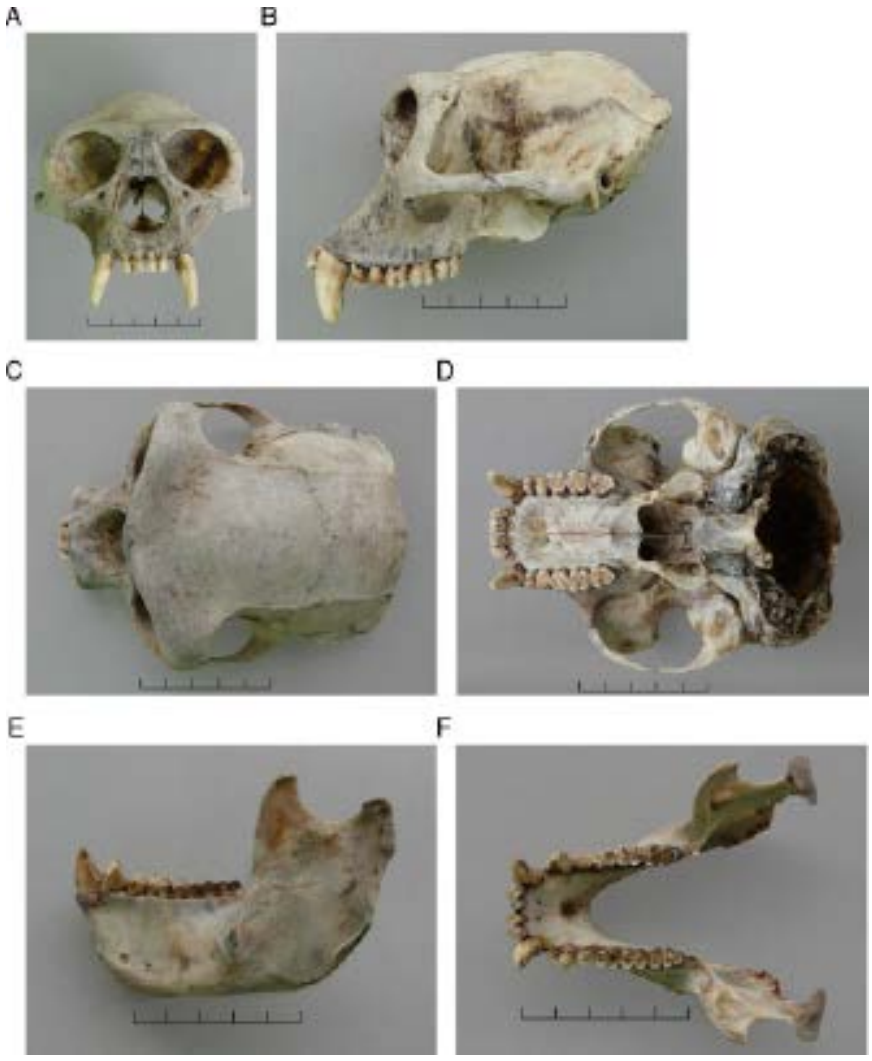

Figure 8. Skull and mandible of the adult male holotype (AIMZ 15504.a). Photos: Thomas Geissmann.

2.3 Geographical Distribution

Intensive field studies by FFI and BANCA (Momberg et al. 2010; Lwin et al. 2010; Aung et al. 2011a; Aung et al. 2011b; Aung et al. 2011c; Tun & Lin 2012; Tun et al. 2012; Aung et al. 2013; Tun et al. 2013a; Tun et al. 2013b; Aung et al. 2014), Ma et al. (2014), Chen at al. (2015) and Yang et al. (2016) (field surveys, interviews, camera trap studies) between 2010 and 2015 revealed that *R. strykeri* occurs in mountain forests between the N'mai Hka River (Kachin State, northeastern Myanmar) and Salween River (northwestern Yunnan Province, China) divide (Figure 9).

In Myanmar, the species range encompasses the mountain forests in the watershed area of the Maw and Lakin rivers (tributaries to the N'mai Hka River) (Figure 9). The proposed range covers approximately 560 km^2 (~N26.35°-26.63°; ~E98.35°-98.68°).

In China, the main distribution area of the species is reported in the Eastern slopes of Gaoligong Mountains Range, Lushui County, Yunnan Province. This range is located ~N25.96°-26.32° and ~E98.59°-98.81° (Ma et al. 2014), bounded to the east by the Salween River. Ma et al. (2014) estimated a total of ten groups. Three of them (C7, C9, C10) are suggested to be cross-boundary groups that may range between China and Myanmar (Ma et al. 2014). Likewise, interviews in Pawaku village (Myanmar) from 2012 indicate the presence of cross-boundary groups (M5) (Aung et al. 2013). The interviewed villagers reported group sizes of 30-100 individuals between 2001 and 2010 (Aung et al. 2013).

During surveys in 2015, Yang et al. (2016) confirmed another Chinese subpopulation (C5, Luoma) on the eastern slope of Gaoligong Mountains towards the Salween River. They recorded 18 individuals on camera traps, but estimated the size of this population at more than 70 individuals. This population is only 14 km away from the Pianma population (C8). It is not clear if there is any connectivity between both groups (Yang et al. 2016).

The total geographical range of *R. strykeri* in China and Myanmar covers about 2300 km^2 between N25.96°-26.63° and E98.35°-98.81° (Figure 9). Based on modeling, the current geographical distribution for *R. strykeri* is predicted to be in the range of N25.67°-26.83° and E98.33°-98.83°, with a total area of ~3575 km^2, of which the core habitat is 1420 km^2, medium-quality habitat is 750 km^2, and low-quality habitats are 1405 km^2 (Figure 10). Among these habitats, 2444 km^2 (68.4%) are in Myanmar and 1131 km^2 (31.6%) are in China (Ren et al. 2017).

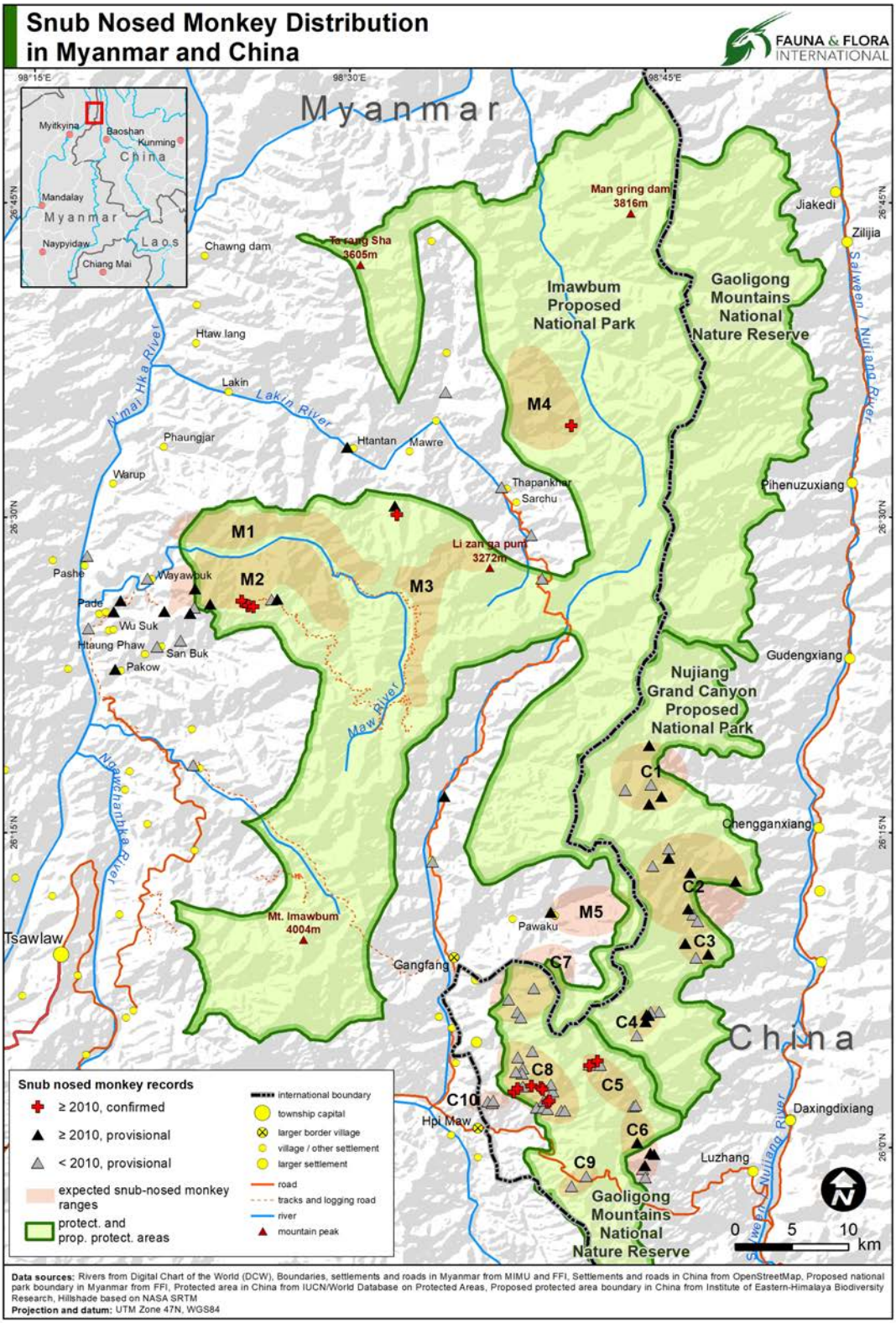

Figure 9. Distribution of *R. strykeri* in Myanmar and China. Confirmed records: direct sighting by survey team members and/or camera trap evidence; provisional records: all other information (interview, skull, etc.). For detailed record information see Appendix A. M1-M5 and C1-C10 refers to proposed snub-nosed monkey subpopulations.

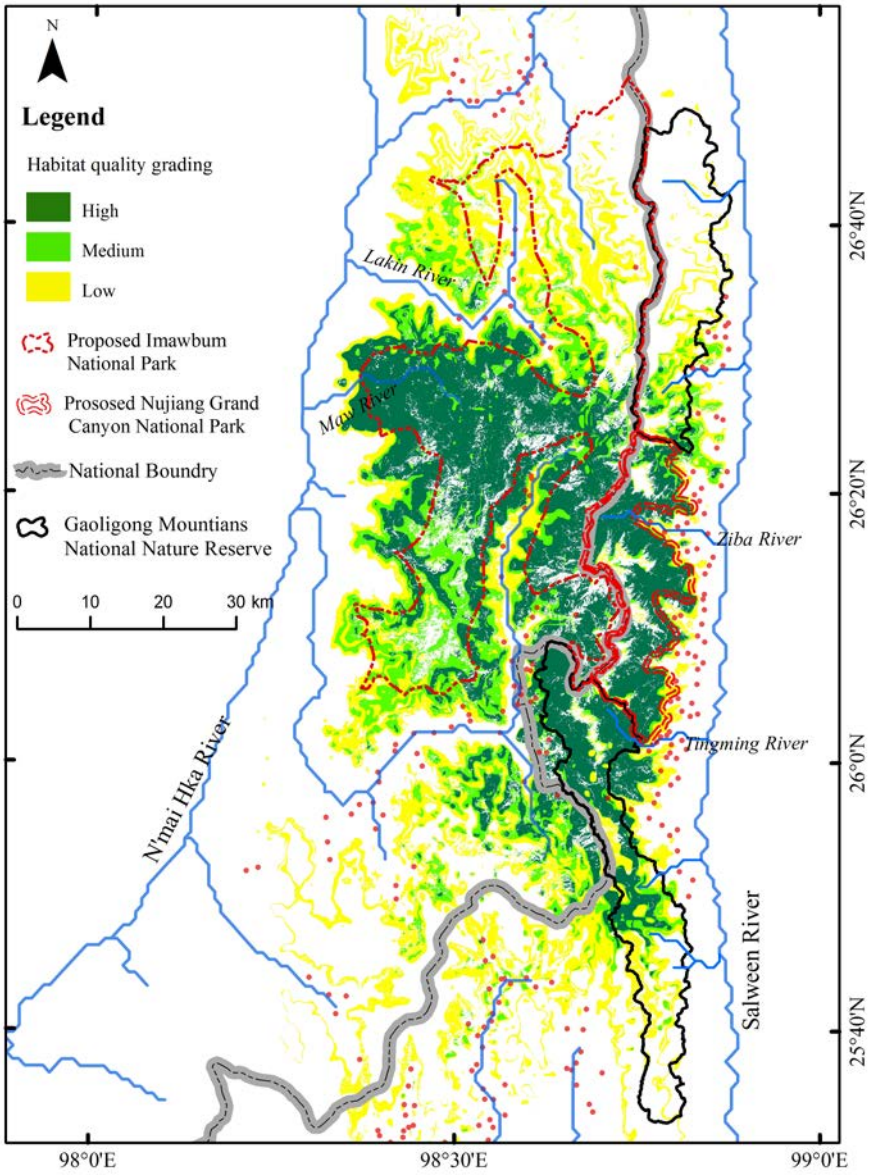

Figure 10. Predictive habitat distribution and quality map according to climate niche analysis, forest cover in 2015 and MAXENT (for details see Ren et al. 2017).

2.4 Habitat, Ranging Pattern and Feeding

R. strykeri inhabits mountainous areas with steep slopes at altitudes between 1720 and 3190 m asl in Myanmar (Geissmann et al. 2011) and 1850-3300 m asl in China (Li et al. 2014; Ma et al. 2014) (Figure 11).

In Myanmar, the inhabited forests are characterized as humid evergreen broadleaf forest (1830-2440 m asl), mixed conifer and broadleaf forest (2135-2745 m asl) and coniferous forest (2745-3660 m asl). According to Ward (1921), who studied the botanical composition of these forests in 1914, the humid evergreen broadleaf forest is indicated by the appearance of a main belt of large shrub rhododendrons. The mixed conifer and broadleaf forest is transitional between

broadleaf forest at lower altitudes and coniferous forest above. The dominant genera are *Acer, Prunus,* and *Ilex* (probably important food sources for *R. strykeri*), as well as *Quercus, Magnolia,* and *Rhododendron* (Ward 1921). The conifer zone is dominated by *Tsuga dumosa*, but also contains species of *Abies*, *Acer, Betula, Rhododendron*, and *Magnolia*. At higher altitudes, the forest is more open and bamboo (*Arundinaria*) thickets occur (Ward 1921; Momberg et al. 2010).

In China, Chen et al. (2015) identified *Quercus kongshanensis* and *Lithocarpus variolosus* at altitudes between 1800 and 2800 m asl (mid-mountain humid evergreen broadleaf forest), *Tsuga dumosa* and *Rhododendron protistum* at altitudes between 2700 and 3100 m asl (Yunnan hemlock forest) as dominant species. Altitudes over 3100 m asl (bamboo-conifer mixed forest) are dominated by bamboo (Chen et al. 2015), as well as *Abies delavayi*, *Ribes himalense*, *Gaultheria cardiosepala*, and *Rhododendron mallotum* (Xue 1995).

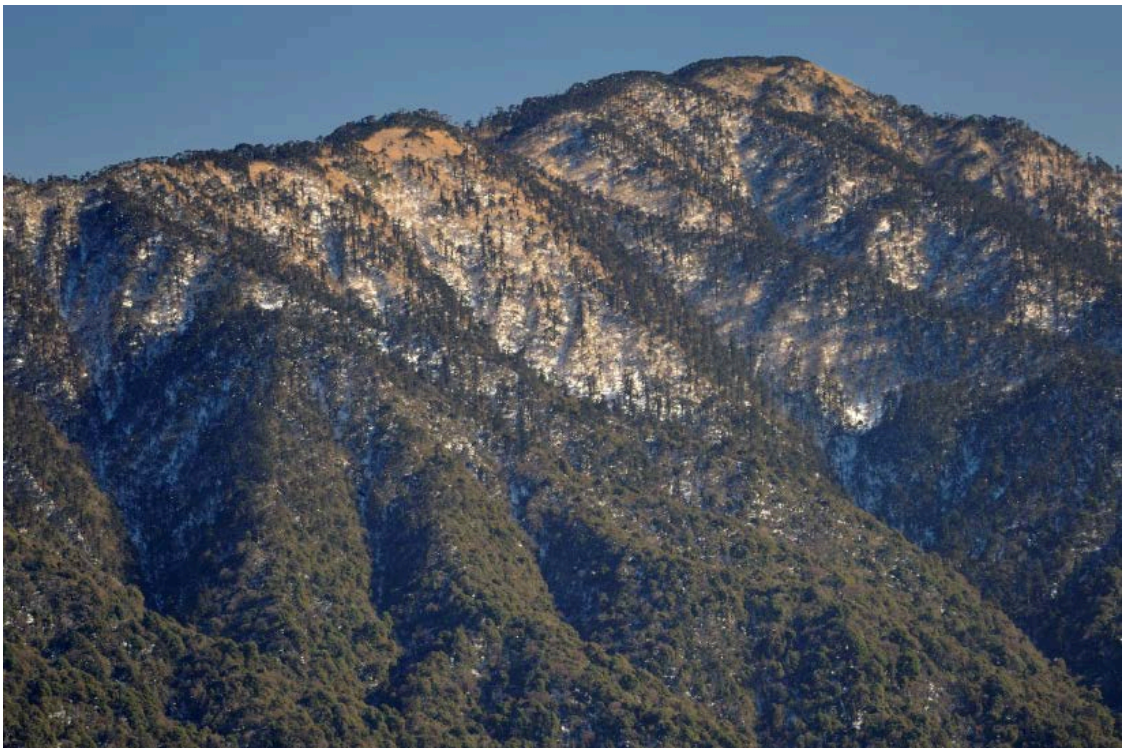

Figure 11. Habitat of *R. strykeri* in Myanmar. Photo: Jeremy Holden.

Ma et al. (2014) suggested a preferred altitudinal range of *R. strykeri* between 2600 and 3100 m asl in China. Likewise, the recent study by Chen et al. (2015) at the Pianma site in China could not find evidence for frequent ranging patterns below 2400 m asl or above 3300 m asl. This is in accordance with reports of local hunters in Myanmar who observed snub-nosed monkeys occupying mostly mixed forests and the silver fir forests in the snow-free time (between May

and October) and at lower elevations when snowfall restricts the availability of food (Momberg et al. 2010).

The first direct dietary information for *R. strykeri* came from a video recording, which shows individuals feeding on *Dodecadenia grandiflora*, *Schefflera* sp. and *Eurya* sp. (Yunnan TV 2013). Yang et al. (2016) observed snub-nosed monkeys eating *Dodecadenia grandiflora* and *Gamblea aciliata*. Bamboo shoots are also part of the species' diet (Geissmann et al. 2011).

Based on preliminary results derived from the Pianma group, home range sizes for *R. strykeri* are estimated at 12 km^2 (Li et al. 2014) and 22.9 km^2 (Chen et al. 2015). The larger home range size is similar to those reported for other species of the genus like *R. bieti*, *R. roxellana* or *R. brelichi* (Kirkpatrick et al. 1998; Li et al. 2000; Tan et al. 2007; Xiang et al. 2013).

2.5 Social Organization and Group Composition

First studies based on video recordings, direct observations and camera trapping revealed that, like in other *Rhinopithecus* spp., *R. strykeri* exhibits a multilevel social organization with one-male–multi-female units and all-male units (Li et al. 2014; Chen et 2015).

The studied group with a total of 90 individuals consisted of 31 adult males, 29 adult females, seven juveniles, seven infants, and 16 non-classed individuals (Chen et al. 2015). The ratio of adult males to adult females was 1:1.1, females to infants 4.1:1 and mature to immature individuals 4.3:1. Accordingly, less than a quarter of the investigated population will represent the future mature population and further females have fewer offspring than in stable populations of other *Rhinopithecus* spp. (Kirkpatrick et al. 1998; Tan et al. 2007; Xiang et al. 2013). These numbers indicate an alarming decreasing trend for this group.

3 THREATS

3.1 Hunting

Based on interviews with hunters in Myanmar, at least 13 snub-nosed monkeys have been hunted in a single year (2009), and at least 78-79 snub-nosed monkeys were hunted during the last 20-30 years (Momberg et al. 2010). These numbers are conservative estimates, as not all hunters could be consulted. In addition, hunters who caught monkeys 20-30 years ago may not remember all specimens they caught, and some hunters who were active during this time period may not be alive anymore (Geissmann et al. 2011). The last reported case of a hunted snub-nosed monkey in Myanmar is from March 2016. The fresh body of this specimen was sold to China (Y. Yang, pers. com.). For China, 19 hunted Myanmar snub-nosed monkeys were reported, of which 15 were hunted before 2000 (Ma et al. 2014). After the implementation of the National Natural Forest Protection Policy in 1998 and increased patrols by nature reserve staff, hunting in China was reduced since 2000 (Ma et al. 2014).

Lisu and Law Waw people traditionally hunt wildlife for food and traditional medicine. They originally hunted with cross bows, home-made black powder guns and snares, but recently shifted to factory-made shotguns with bullets and iron traps, both available in Gangfang. Hunting with snares is also common. The main target species for wildlife trade are sun bear (*Helarctos malayanus*) and Asiatic black bear (*Ursus thibetanus*). Bears are trapped with iron traps set-up with meat bait or hunted with shotguns when encountered in the forest. Although not target species, monkeys, including snub-nosed monkeys, are trapped unintentionally in iron traps that were set-up for bears. Depending on the weight of valuable bear parts (gold bladder, paws/legs) local hunters can sell bears for 4000 to 10,000 Yuan per animal.

Figure 12. Skull and foot of a hunted *R. strykeri*. Photo: Tin Aung Tun.

The presence of Chinese logging and road construction camps in Myanmar has further increased the demand for bushmeat. Accordingly, local hunters that formerly hunted only for subsistence use, hunt now for muntjak, serow and wild boar to supply the Chinese camps with fresh meat. This bushmeat sells for 500 Yuan on average per animal and hunters from San Buk village earned 10,000 Yuan per year from hunting and trapping wildlife (Momberg et al. 2010; Geissmann et al. 2011). Snub-nosed monkeys, macaques and langurs have been also hunted and trapped for their heads (skull and brain) and bones to be sold to nearby Chinese logging and road construction camps, as well as to wildlife traders in Gangfang. Monkey heads can be sold for 100-150 Yuan and bones are sold for 150 Yuan per *vis* (1 *vis* = 1.7 kg) (Figures 12 & 13).

Figure 13. A hunter's collection of primate skulls in Maw Ban village including macaques, langurs and snub-nosed monkeys. Photo: Frank Momberg.

3.2 Non-timber Forest Product Extraction

Access to Chinese markets has also increased the extraction of non-timber forest products (NTFP). Medicinal plants (bark, roots and whole plants), ornamental plants (orchids) and wild mushrooms are sold to Chinese camps. As shotguns are carried on NTFP collection trips, the demand for NTFPs also results in a further increase of opportunistic hunting. Medicinal bark (Lisu name: *shikutgi*) was collected in large quantities in 2009 and 2010 (Figure 14). More than

ten people collected this bark to fill up a truckload for 50,000 Yuan. Another important medicinal plant is *shishe* (Lisu language). Its root is used for malaria treatment. Roots of *Deban daing* are collected and sold for 100 Yuan per *vis* (1 *vis* = 1.7 kg) in the nearest Chinese road construction camp. *Kwabuoimutschi* mushrooms (Lisu name: *gyipu*) are sold for 1,500 Yuan per *vis* (F. Momberg, pers. com.). In China, the human population in Nujiang Prefecture, at least partly depending on forest products, increased from 4.92 million in 2000 to 5.34 million in 2010 (Ma et al. 2014), thus increasing pressure on snub-nosed monkey habitat.

Figure 14. Tree bark collection in Myanmar. Photo: Saw Soe Aung.

3.3 Logging and Road Construction

Roads for logging from the border town of Gangfang have opened up the entire area (Figure 15). The Chinese Yin Toak Company had a five-year-contract (2008-2012) to construct roads for logging in the upper N'mai Hka watershed. The company built two logging roads towards the habitat of the snub-nosed monkeys to access precious woods in the upper mountain forest and conifer zone. One road goes South of the Maw River via San Buk village, the other one North of the Maw River via Wayawbuk village. Both logging roads must go through steep slopes with 30-70° slope inclination, and their construction so far has led to large-scale landslides impacting Taungya (shifting cultivation areas), secondary and primary forests. Forest destruction by road construction and logging has and will have a tremendous impact on the integrity on the habitat of the snub-nosed monkeys (Win Myint & Ei Ei Phyo, in prep.). Primary forests have been logged and degraded up to some of the highest mountain peaks (F. Momberg, pers. com.). Noise of explosives used in road construction could affect the behavior of the snub-nosed monkeys, including their reproduction and group dynamics. Local timber extraction also increases the chance for opportunistic hunting (F. Momberg, pers. com.).

Figure 15. Logging trucks in Myanmar. Photo: Ngwe Lwin.

Main target species extracted by local communities are conifer trees with scented wood that are also called coffin trees (*Taiwania cryptomerioides*) for their use in China and maple trees (*Acer* spp.). Further target species are *Taxus yunnanensis*, *Manglietia* spp. and *Michelia* spp..

The trans-boundary ban signed by the governments of China and Myanmar in 2015 significantly reduced illegal transboundary activities such as logging, mining, and gold panning in Myanmar, although these activities might have not been stopped completely.

Figure 16. Dam construction on the Chibwe River by China Power Investment. Photo: Frank Momberg, taken in April 2010.

3.4 Dam Construction

In December 2006, the China Power Investment Corporation (CPI) and the Myanmar Ministry of Electrical Power signed a Letter of Intent for the Hydropower Development in the Snub Ayeyarwaddy River Basin above Myitkyina, Kachin State. Seven cascade hydropower stations are to be built in the hydropower development scheme of the Ayeyarwaddy River Basin upstream from Myitkyina. Five of these cascade power stations are built on the N'mai Hka River, one power station is built on the Mali Hka River, and one is built 5 km downstream from the confluence of the latter two rivers on the Ayeyarwaddy River. The total installed capacity of basin cascade development of the Ayeyarwaddy River above Myitkyina is 16,500 MW (BANCA 2009). The distribution range of the sub-nosed monkeys is largely located in the watershed of the planned Wu Suk Dam and partly in the watershed of the Chibwe Dam (Figure 16). Indirect impacts on biodiversity, such as logging, hunting and wildlife trade, are expected to be severe. The construction of access roads for the dams will allow all-year-round and all-weather access to the mountain forests, including the whole distribution area of the snub-nosed monkeys of Kachin, and this will lead to increased logging and unsustainable NTFP extraction in these areas. This will also open cheap opportunities for logging companies to build secondary logging roads (F. Momberg, pers. com.). President U Thein Sein has suspended the CPI hydropower project until end of his government term in March 2016 (International Rivers 2011). The project is currently under revision by a commission of review of the new Myanmar government (Shining 2016).

3.5 Other Threats

Due to its limited geographic distribution, small population size and relatively long life history, *R. strykeri* is highly vulnerable to environmental, demographic and genetic stochasticity, and therefore faces a naturally high risk of extinction. Small and fragmented populations may lose allelic richness or genetic diversity, and have increased population differentiation due to genetic drift and inbreeding depression. Such populations are less adaptable to environmental changes and a single catastrophic event – natural or human-caused – like a forest fire or a disease could lead to dramatic population size reduction or even extinction of the species. Climate change should be considered another threat as it could alter habitat suitability and diminish the capacity of the currently inhabited areas.

4 CONSERVATION STATUS

The Myanmar or black snub-nosed monkey is currently listed as Critically Endangered on the basis of criteria A4cd (IUCN 2001, Appendix B): "*Geissmann et al. (2011) estimated a three-generation period for this species of 18 years, and the time-frame used for this assessment applies to the past three years and is projected forwards for the next fifteen years. The total population size was estimated between 260 and 330 individuals. Based on the interviews with hunters (Momberg et al. 2010), at least 13 Myanmar snub-nosed monkeys were hunted during 2009. If this figure is extrapolated to three-generation spans (at least 18 years), the rate of loss would be 234 monkeys, or 90% of the conservatively estimated current total population of 260 individuals. Under this scenario, in order to keep hunting success stable with decreasing supply, hunting effort would have to increase. All the evidence on threats indicates that hunting pressure (directed and undirected) is likely to increase considerably in the next few years as new dam construction and logging roads invade the distribution area of this newly discovered snub-nosed monkey. The 90% population reduction scenario also implies that will be very little to no population growth, although this may be unlikely, it is very probable that there will be increasingly less recruitment over the next fifteen years as the population declines. Hence an estimated and projected population reduction of more than 80% over the three generation period seems perfectly reasonable for this highly threatened species.*" (Geissmann et al. 2012).

After several years of field work in Myanmar there is still a lack of direct encounters by professional staff (local FFI and BANCA biologists or others). Most information on observed group sizes has been derived from interviews with local hunters and villagers. It is remarkable that local hunters also rarely encounter snub-nosed monkey groups. A similar situation is reported for China, where only 67 of 358 interviewed villagers confirmed the presence of *R. strykeri* and 90% of them just saw the monkeys once in their life (Ma et al. 2014). Most likely these rare encounters are due to the monkeys' relatively large home ranges, their shy nature, their occurrence in high altitudes and the rugged and harsh terrain they inhabit, but probably also because of generally low population numbers. The only subpopulations that were studied in more detail are the Pianma and Luoma populations at the south slope of Gaolingong Mountains National Nature Reserve in China.

Geissmann et al. (2011) originally proposed three ranges based on interview evidence, of which only the one south of the Maw River (range 2 in Geissmann et al. 2011; M2 in Figure 9) was subsequently confirmed by direct sightings and camera trap records (Aung et al. 2011a). Tun et al. (2013a) confirmed the presence of the species north of the Maw River, between range 1 and 3 (Geissmann et al. 2011). Hence, we suggest to lump these two ranges north of the Maw River

(M1 and M3) into one subpopulation. In 2013, a FFI team discovered a further subpopulation north of Lakin River (M4) (Aung et al. 2013).

Based on interview evidence Ma et al. (2014) estimated 490-620 individuals in ten subpopulations in China. However, only two Chinese subpopulations, one near Pianma (C8), at the western slope in southern Gaoligong Mountains Range and another one at the eastern slope (Luoma, C5) could be confirmed by direct sightings or camera trap evidence (Chen et al. 2015; Yang et al. 2016), while all other records derived solely from interviews. Interview data provide also indications for possible cross-boundary groups between China (in the southern Gaoligong Mountains Range, Ma et al. 2014) and Myanmar (near Pawaku village, M5, Aung et al. 2013).

We provisionally recognize five subpopulations: (1) South of the Maw River (M2), (2) North of the Maw River (M1-M3), and (3) North of the Lakin River in Myanmar (M4), and (4) in the southwestern slopes of the Gaoligong Mountains Range (Pianma, C8) and (5) in the southeastern slopes of Gaoligong Mountains Range (Luoma, C5) in China. For none of these subpopulations we have any evidence that the subpopulation contains more than 100 individuals (Lwin et al. 2010; Tun et al. 2012; Tun et al. 2013b; Li et al. 2014; Chen et al. 2015; Yang et al. 2016). We conservatively estimate the total population to a minimum of only 400 individuals. Furthermore, the connectivity of habitats is highly doubtful due to forest degradation, roads, human settlements and major rivers, and thus, gene flow between subpopulations might be interrupted.

Although overall population estimates for *R. strykeri* might be higher and the area of occurrence might be larger (Ren et al. 2017) than postulated in the earlier IUCN assessment (Geissmann et al. 2012) and by recent field data, most information on *R. strykeri* is still mainly based on interviews with local people and not on direct observations. Further, although the species' protection might have been improved and targeted hunting reduced in recent years, changing the current IUCN Red List status would be inappropriate due to the scarcity of reliable data.

5 CONSERVATION RECOMMENDATIONS

Since 2011, FFI in collaboration with the Myanmar Forest Department have made significant contributions for the conservation of the species in Myanmar, despite significant security risks during project implementation. Intensive surveys expanded the knowledge on the distribution and ecology of the species. The process of defining and gazetting a protected area for the species, Imawbum National Park has completed, involving the Forest Department, Kachin state government and local villages. The gazettement decree is expected to be issued by the Myanmar government in 2018. In addition, conservation awareness has increased at the site-level through village consultations and awareness activities in all 54 villages surrounding the proposed Imawbum National Park, which already had a clear effect on the reduction of hunting pressure on the monkeys. All of the 23 established community conservation groups agreed upon the creation of a non-hunting core zone.

The need to recognize traditional resource rights has become part of the discourse on protection of *R. strykeri* and its habitat. Imawbum National Park was the first protected area in Myanmar that has been gazetted through a comprehensive consultation process of indigenous people based on free and prior informed consent. A small grant program for alternative livelihoods has been launched and its benefits can be expected to materialize over the coming years.

Although there has been no immediate armed conflict at the project site, access has been hampered at times due to access roads passing through Kachin Independence Army (KIA) controlled territory. However, since 2015 the security conditions have improved, allowing the gazettement process of Imawbum National Park to be completed.

In 2014, Nujiang Autonomous Prefecture initiated the gazettement process for Nujiang Grand Canyon National Park with the intention to develop a harmonious win-win solution for both biodiversity conservation and economic improvement, in particular through alleviating poverty of the local communities. In 2016, the master plan for Nujiang Grand Canyon National Park has been approved by the Yunnan National Park Committee. The Nujiang Grand Canyon National Park consists of the Gaoligong Mountains on the West bank of the Salween River and the Biluo Snow Mountain on the East bank. The western part of the national park will foster protection of Chinese snub-nosed monkey populations that so far occur in unprotected areas (C1-C5). The park lies between strictly protected nature reserves and scenic spots that are open to the public. Local villagers around the park will be encouraged to be hired by the park for conservation work (such as zoning and patrolling) and to develop eco-tourism (such as wildlife/bird watching, agro-tourism and folk-custom tourism) as well as to produce and sell local specialties and handicrafts.

Since 2015, Tengcong County and Nujiang Autonomous Prefecture increased the enforcement of the *Agreement Between the Government of the People's Republic of China and the Government of the Union of Myanmar on China-Myanmar Border Areas Management and Cooperation* and the *Protocol Between the Ministry of Public Security of the People's Republic of China and the Ministry of Home Affairs of the Union of Myanmar on Cooperation in Border Areas* to prohibit Chinese citizens entering Myanmar for illegal activities. The ban emphasizes illegal activities such as illegal logging, mining, panning gold and moor-burning.

In December 2016, a workshop on *Opportunities for Trans-boundary Collaboration for Conservation and Development along the Northern Section of the China-Myanmar Border* was held in Kunming. Participants were scientists, national park and NGO staff, and government officials from both countries. The workshop identified *R. strykeri* as one of the key species for trans-boundary collaboration on conservation in the northern section of the China-Myanmar border. "*The declaration of the workshop by key representatives from the participating institutions recognized that cross-border collaboration between different levels and sectors in China and Myanmar is critically needed in the trans-boundary landscape in the following areas: a) collaboratively control wildlife poaching, overharvesting of forest products and illegal trading of biological resources, and establishing in-time communication mechanisms/channels for forest fire prevention; b) protect and monitor key species and key habitats under a common implementation framework; c) develop and share scientific information and data on biodiversity conservation and natural resource use; d) promote sustainable livelihood options for border area communities aiming to reduce poverty and mitigate conflict between protected areas and local communities; and e) enhance institutional capacities including staff capacity and infrastructure to enable effective biodiversity conservation*" (Basnet et al. 2017).

5.1 Outstanding Achievements in Myanmar to Date

1. Comprehensive biodiversity and socio-economic surveys to prepare the gazettement of Imawbum National Park, with participation from FD, BANCA and FFI.
2. Extension of the known distributional range of *R. strykeri* to the North-East of the FFI project area. New groups have been identified.
3. First video footage of the species in the wild in Myanmar recorded by a local villager working as a project ranger.
4. Expanded local conservation constituency with 25 villages in the proposed national park buffer zone leading to the establishment of 23 conservation groups, all of which signed conservation stewardship agreements and received small grants for livelihood activities.

5. Agreement from all stakeholders on local, state and national level for the designation of Imawbum National Park.
6. Participatory delineation of park boundaries through village land use mapping and village consultation based on the principles of free and prior, informed consent. Boundaries exclude both land and forest utilization areas by local communities to safeguard the subsistence and economic needs of local indigenous communities, while safeguarding the *R. strykeri* range and key biodiversity areas.
7. Intensive awareness campaigns in all 54 villages in the area have been conducted. Since then, snub-nosed monkey hunting was drastically reduced.
8. All of the 23 established community conservation groups agreed upon the creation of a non-hunting core zone.
9. The technical/biological justification for Imawbum National Park has been completed submitted to and accepted by both state and national government.
10. Kachin State Government and the Myanmar Forest Department have finalized the participatory gazettement process for Imawbum National Park with support from FFI. The official notification is expected in 2018.

5.2 Outstanding Achievements in China to Date

1. Comprehensive biodiversity surveys provided detailed information about the species' distribution in China. Two populations (C5, C8) were confirmed by direct observations.
2. First data on social structure and home range of the species were collected by field observations and camera trap studies.
3. Snub-nosed monkey populations outside Gaoligong Mountains National Nature Reserve will be included in the proposed Nujiang Grand Canyon National Park. In 2016, the master plan for Nujiang Grand Canyon National Park has been approved by the Yunnan National Park Committee.
4. The Yunnan Provincial Government will include most of the species' habitat into the ecological protection red line for strict eco-conservation.
5. Strict implementation of the ban on trans-boundary violations by the government of China since 2015, which has largely reduced illegal activities such as logging, mining, gold panning and moor-burning in the species' habitat in Myanmar.
6. Since 2015, *R. strykeri* is included in the program Conservation Priorities of Species with Extremely Small Populations of the Yunnan Provincial Government that supports conservation actions and research.

5.3 Next Steps towards Long-term Protection

- Conduct further research on *R. strykeri*, particularly to obtain more conservation relevant data (habitat requirements, spatial needs, threats, etc.).
- Complete the designation process and establishment of the Imawbum National Park. This is a government-led process. However, FFI will monitor the process and provide technical advice when needed. The next step for the government will be to set up a park management unit, develop a management plan for the national park, and then start operations.
- Complete the designation process and establishment of Nujiang Grand Canyon National Park. This is a government-led process. Scientists and research institutes will provide technical advice when needed. The next step for the government will be to establish the park management unit, develop a management plan for the national park, and then start operations.
- Establish, expand and secure migration corridors to facilitate migration and gene exchange among extant snub-nosed monkey subpopulations.
- Continue intensive awareness campaigns specifically targeting bushmeat consumption and wildlife trade.
- Support livelihood interventions to alleviate poverty that reduce dependency on hunting and shifting cultivation, such as agroforestry and livestock raising.
- Monitoring the impact of community conservation agreements, alternative livelihood interventions and awareness activities.
- Monitor wildlife trade and illegal logging in the border region.
- Foster trans-boundary collaboration on law enforcement and research between China and Myanmar.
- Establish and operate collaborative patrolling and law enforcement systems and monitor the snub-nosed monkey populations.
- Secure funding and provide technical assistance for the establishment of the national parks, management planning and start-up of operations.

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APPENDIX A – SNUB-NOSED MONKEY RECORDS

Note on last records:

confirmed: only direct sightings by survey team members and/or camera trap evidence

provisional: all other information (interview, skull, etc.)

Myanmar: Tsawlaw District, Kachin State

Type locality (N26.43101°, E98.38894°; 2815 m)

Geissmann et al. 2011

Group affiliation: M2

Record status: holotype, dead specimen (2010); last record (provisional) 2010

Skull (with mandible), skin, and photographs (Figures 7 & 8) of gutted carcass of adult male collected by Ngwe Lwin, Saw Soe Aung, Thet Naing Aung, and Zin Myo Aung on March 7, 2010 from two hunters from Pade village who had caught the individual one or two days before, South of the Maw River. The skull and skin (AIMZ 15504.a and 15504.b respectively) have been deposited in the Anthropological Institute and Museum of the University of Zurich (AIMZ), Zurich, Switzerland. The trapping locality of the holotype was determined as N26.43101°, E98.38894° (2815 m) (Geissmann et al. 2011).

Htantan village (N26.55563°, E98.49789°; 1533 m)

Geissmann et al. 2011

Group affiliation: M1

Record status: paratypes, skulls (2007), bag (2010); last record (provisional) 2010

Two adult skulls, one male and one female, collected by Ngwe Lwin and Saw Soe Aung on February 23, 2010 from a hunter from Htantan village. The hunter collected these specimens ~2007 from North of the Maw River. On the same day, Ngwe Lwin and Saw Soe Aung obtained a bag from another hunter who had made the bag out of the skin of a juvenile. The animal was caught in January 2010, also North of the Maw River. The female skull (AIMZ 15505) has been deposited in the primatological collection of the Anthropological Institute and Museum of the University of Zurich (AIMZ), Zurich, Switzerland. The male skull (BANCA 2010.6) and the bag (BANCA 2010.4) have been deposited in the zoological collection of Hlawga Wildlife Park, Yangon Division, Myanmar (Geissmann et al. 2011).

Near Camp 3 (N26.43300°, E98.41393°; 2503 m)

Momberg et al. 2010, Geissmann et al. 2011

Group affiliation: M2

Record status: interview (2010), direct sighting (2010); last record (confirmed) 2010

On May 1, 2010, local survey team members Le Me A Si and Dai Laum from San Buk village encountered a group counting at least six individuals and one infant at 1.3 km North-East of Camp 3. Near this site, team members met a hunter from Ngaw Phar Kar village near Gangfang. He has been hunting and trapping wildlife in this area for the past three years. He last saw a group of ~80 individuals at the beginning of April 2010. In 2009, he caught three adults in iron traps (Momberg et al. 2010, Geissmann et al. 2011).

Between Camp 1 and Camp 2 (N26.42814°, E98.37643°; 2488 m)

Momberg et al. 2010

Group affiliation: M2

Record status: interview (2010); last record (provisional) 2009

A hunter from San Buk village shot two adults in May 2009 between Camp 1 (N26.41898°, E98.35752°; 2,374 m) and Camp 2 (N26.42835°, E98.38884°; 2,764 m) (Momberg et al. 2010).

Lower conifer zone (N26.43457°, E98.43764°; 3187 m)

Momberg et al. 2010

Group affiliation: M2

Record status: interview (2010); last record (provisional) 2009

A hunter from San Buk village shot three adults and one infant in December 2009 (Momberg et al. 2010).

San Buk village (N26.39701°, E98.34699°; 1541 m)

Momberg et al. 2010

Group affiliation: M2

Record status: interview (2010); last record (provisional) 2007

A hunter from San Buk village hunted one individual three years ago (~2007) and another hunter hunted 2-3 individuals before 2007 (Momberg et al. 2010).

Maw Ban village (N26.40207°, E98.36563°; 1750 m)

Momberg et al. 2010

Group affiliation: M2

Record status: skull (2010); last record (provisional) unknown

In a headman's house, a skull of unknown age was found (Momberg et al. 2010) (Figure 17).

Figure 17. Skull of an adult female snub-nosed monkey in a hunter's house in Maw Ban village. Photo: Ngwe Lwin.

Pade village (N26.42486°, E98.31237°; 1012 m)

Momberg et al. 2010, Lwin et al. 2010

Group affiliation: M2

Record status: interview (2010); last record (provisional) 2010

A hunter from Pade village hunted one individual in January 2010 (Momberg et al. 2010). All four hunters interviewed by Lwin et al. (2010) encountered monkeys. They have seen small (~5 individuals) to large (~40-50 individuals) groups.

Wayawbuk village (N26.45128°, E98.33942°; 1741 m)

Momberg et al. 2010, Aung et al. 2011c

Group affiliation: M1

Record status: interview (2010); last record (provisional) 2009

A hunter from Wayawbuk village hunted one individual 2-3 years ago (~2007-2008) and another individual ~10 years ago (~2000). Another hunter hunted one individual also ~10 years ago (~2000) (Momberg et al. 2010). According to Aung et al. (2010c), a monkey was caught North of the Maw River in 2009.

Pashe village (N26.46944°, E98.29163°)

Momberg et al. 2010

Group affiliation: M1

Record status: interview (2010); last record (provisional) 2009

Two hunters from Pashe village hunted two individuals ~10 years ago (~2000). Another hunter hunted one individual in late 2009.

Chichitago village (N26.48587°, E98.64373°; 1880 m)

Momberg et al. 2010, Lwin et al. 2010

Group affiliation: M3

Record status: interview (2010); last record (provisional) 2009

A hunter from Chichitago village hunted three juveniles in 2009 and ~50 individuals in the last 20-30 years (Momberg et al. 2010). Lwin et al. (2010) interviewed three hunters: Hunter 1 said that the group consists of ~100 individuals and usually comes to the mountain range West of the village in June or July. They stay only a week at that place and he thinks they are moving from one place to another. Many years ago, they used to come close to the village. He has shot many animals at that place. Before the Gangfang-Lanse motor road has been built, the group used to travel from West to East of the village along the Marcos Mountain Range during the rainy season. Hunter 2 said that the group usually comes to the mountain range West of the village during the rainy season. Hunter 3 said that the group consists of ~40-50 individuals and usually comes to the mountain range West of the village in the rainy season. He hunted 4-5 animals in that area.

Thapankhar village (N26.52380°, E98.62013°; 1662 m)

Lwin et al. 2010

Group affiliation: M3

Record status: interview (2010); last record (provisional) 2008

Lwin et al. (2010) interviewed three hunters in Thapankhar village: Hunter 1 hunted two animals South of the village about one day walking distance during winter time (December and January, year unknown). Hunter 2 saw a group consisting of ~50 individuals South of the village about one day walking distance during winter time ~ five years ago (~2005). He shot two animals. Hunter 3 has seen groups twice within 10 years South of the village ~ one day walking distance. He hunted three animals in winter 2008.

Dekyi village (N26.45121°, E98.65215°; 2582 m)

Lwin et al. 2010

Group affiliation: M3

Record status: interview (2010); last record (provisional) 2001

A villager from Dekyi village said that ~8-9 years ago (~2001-2002), before the Gangfang-Lanse motor road has been built, a group was usually found around the village in June. The group used to travel along the Marcos Mountain Range at that time. After the road has been built, he never saw the group around the village and on the Marcos mountain range again (Lwin et al. 2010).

Larolo village (N26.27862°, E98.57498°; 1770 m)

Lwin et al. 2010, Tun et al. 2012

Group affiliation: M3

Record status: interview (2010); last record (provisional) 2011

The leader of Larolo village knows the monkeys. They occur on the mountain range North-West of the village. 4-5 years ago (~2005-2006), some hunters from the village hunted the monkeys, but do not do so nowadays (Lwin et al. 2010). According to Tun et al. (2012), a hunter from Larolo village encountered a group with ~100 individuals in Maluhou Mountain Range in June 2011.

Ngaw Phar Kar village (N26.22669°, E98.56535°; 1714 m)

Lwin et al. 2010

Group affiliation: M3

Record status: interview (2010); last record (provisional) unknown

The leader of Ngaw Phar Kar village knows the monkeys, but they do not occur near the village. Nobody in the village hunts the monkeys (Lwin et al. 2010). However, survey team members met a hunter from Ngaw Phar Kar village near Camp 3 (N26.43300°, E98.41393°, 2503 m, M2) (Momberg et al. 2010).

Rityaw village (N26.30361°, E98.37571°; 1579 m)

Lwin et al. 2010

Group affiliation: M2

Record status: interview (2010); last record (provisional) unknown

An interviewed hunter from Rityaw village knows the monkeys. They occur around the Ma River. As he hunts usually around his village, he never hunted them (Lwin et al. 2010).

Eight-mile village (N26.43360°, E98.31807°; 1202 m)

Lwin et al. 2010

Group affiliation: M2

Record status: interview (2010); last record (provisional) 2010

A hunter from Eight-mile village caught two monkeys with iron traps in March and June 2010. When he goes to that area for hunting and checking his iron traps, he often sees a group of ~50 individuals. In winter, monkeys are usually encountered on the trees and they flee quickly when they notice the presence of humans. In the rainy season, they are usually encountered on the ground eating bamboo shoots or fallen fruits (Lwin et al. 2010).

Wu Suk village (N26.41172°, E98.29234°; 1453 m)

Lwin et al. 2010

Group affiliation: M2

Record status: interview (2010); last record (provisional) unknown

All three interviewed hunters from Wu Suk village have seen the monkeys. During the rainy season from June to September, they sometimes encountered the groups eating bamboo shoots on the ground or sitting at the top of big trees when raining. They have encountered small (~5 individuals) to large (~40-50 individuals) groups (Lwin et al. 2010).

Htaung Phaw village (N26.37925°, E98.31371°)

Lwin et al. 2010

Group affiliation: M2

Record status: interview (2010); last record (provisional) 2010

Both interviewed hunters from Htaung Phaw village encountered a group with ~30 individuals. They hunted monkeys with iron traps in 2009 and 2010 (Lwin et al. 2010).

Between Camp 1 (N26.41898°, E98.35752°; 2374 m) and Camp 2 (N26.42835°, E98.38884°; 2764 m)

Aung et al. 2011a

Group affiliation: M2

Record status: interview (2011); last record (provisional) 2010

A hunter from Pamawzup village caught a monkey with an iron trap between Camp 1 and Camp 2 in June 2010 (Aung et al. 2011a).

Near Salt lick (~N26.43479°, ~E98.44246°; ~3313 m)

Aung et al. 2011a

Group affiliation: M2

Record status: interview (2011); last record (provisional) 2011

A tree bark collector from Gangfang encountered a group (~20 individuals) at the top of the mountain range near the salt lick in March 2011 (Aung et al. 2011a).

Between Camp 1 (N26.41898°, E98.35752°; 2374 m) and Chinese Logging Camp (N26.43144°, E98.34770°; 1813 m)

Aung et al. 2011a

Group affiliation: M2

Record status: interview (2011); last record (provisional) 2011

A hunter encountered a group of 15-20 individuals between Camp 1 and the Chinese Logging Camp in April 2011 (Aung et al. 2011a).

Near Camp 3 (N26.43323°, E98.41404°; 2535 m)

Aung et al. 2011a

Group affiliation: M2

Record status: direct sighting, alive juvenile (2011); last record (confirmed) 2011

Three survey porters encountered a group of 25-30 individuals with 2-3 infants near Camp 3 on April 19, 2011. The group was feeding on the ground and in trees. When the monkeys encountered the team members, they fled and one female dropped its infant. The infant died two days later in the camp. The infant (Figure 18) was grey colored, head-and-body-length: 19 cm, tail: 22 cm, hind foot: 7 cm, ear length: 7 cm (Aung et al. 2011a).

Figure 18. Dead snub-nosed monkey infant at Camp 3. Photo: Saw Soe Aung & Thet Naing Aung.

Camera trap site 3 (N26.42951°, E98.41888°; 2709 m)

Aung et al. 2011b

Group affiliation: M2

Record status: camera trap (2011); last record (confirmed) 2011

Two photos from three individuals taken on May 13, 2011, 10:51 am (Aung et al. 2011b).

Camera trap site 4 (N26.42966°, E98.41917°; 2709 m)

Aung et al. 2011b

Group affiliation: M2

Record status: camera trap (2011); last record (confirmed) 2011

Three photos from snub-nosed monkeys taken on May 13, 2011, 10:50 am (Aung et al. 2011b).

Camera trap site 6 (N26.42890°, E98.42322°; 2876 m)

Aung et al. 2011b

Group affiliation: M2

Record status: camera trap (2011); last record (confirmed) 2011

27 photos from 10 individuals with two infants taken on May 13, 2011, 6:56 am (Aung et al. 2011b).

Near Snow/Hunter Camp (N26.44303°, E98.37706°; 2693 m)

Aung et al. 2011b, Tun & Lin 2012, Aung et al. 2014

Group affiliation: M2

Record status: interview (2011-2012, 2014); last record (provisional) 2013

The survey team recorded a smoked skeleton in Wu Suk village. Its origin was reported to be close to the Snow/Hunter Camp, where a hunter caught the monkey in an iron trap on April 5, 2011 (Aung et al. 2011b). Two hunters from Gangfang and Wu Suk encountered a group of 40-50 individuals near the camp on November 17, 2011 (Tun & Lin 2012). A hunter from Pade village encountered 10-15 individuals when they checked their iron traps in July 2013 (Aung et al. 2014).

Camera trap site 26 (N26.50204°, E98.53713°; 2882 m)

Tun et al. 2013a

Group affiliation: M1/M3

Record status: camera trap (2012), direct sighting (2013); last record (confirmed) 2013

Three photos and a video clip from two individuals were taken on April 1, 2013, 6:38 am (Figure 19). The survey team encountered a group on September 29, 2011. The survey team leader estimated the total population size of this group at ~80 individuals (Tun et al. 2013a).

Figure 19. One of the camera trap photos taken on April 1, 2013. Photo: FFI, BANCA & PRCF.

Shaw Mountain (N26.50893°, E98.53563°; 2777 m)

Tun et al. 2013b

Group affiliation: M1/M3

Record status: skull, foot (2013); last record (provisional) 2013

A skull and a foot were found at a hunter's house in Mawre village. Four local hunters shot a monkey at a sleeping site on Shaw Mountain on February 23, 2013. The hunters estimated a group size there at ~100 individuals. This group was reported to be present in the area from February to October (Tun et al. 2013b).

Hka Ku Chaung Site (N26.57249°, E98.67546°; 3077 m)

Aung et al. 2013

Group affiliation: M4

Record status: interview (2012), direct sighting (2013); last record (confirmed) 2013

Survey team members encountered seven individuals on January 4, 2013. A hunter from Chitwin village encountered ~ 10 individuals in this area in December 2010. Another two hunters, one from Chitwin village, the other from Thabangkhar village, encountered groups with more than 10 individuals in this area in March 2012 and August/September 2012, respectively (Aung et al. 2013).

Kang Kung village (N26.59933°, E98.57590°; 1636 m)

Aung et al. 2013

Group affiliation: M4

Record status: interview (2012); last record (provisional) unknown

A hunter from Kang Kung village said that the monkeys occur South-East of the village around the Maw River and Hka Ku Stream (Aung et al. 2013).

Myanmar: Chipwi District, Kachin State

Pawaku village (N26.18670°, E98.65918°; 2199 m)

Aung et al. 2013

Group affiliation: M5

Record status: interview (2012); last record (provisional) 2010

Hunter 1 encountered ~100 individuals in the forest East of the village in ~ three-hours walking distance in August 2007. ~20 years ago, a villager kept a snub-nosed monkey as a pet. Hunter 2 encountered 30 individuals in the forest East of the village in a ~ one-day walking distance in winter 2010. Due to logging, monkeys probably moved to another area (Aung et al. 2013).

China: Lushui County, Yunnan Province

Gaoligong Mountains Range

Ma et al. 2014

Group affiliation: C1

Record status: interview (2011-2012); last record (provisional) 2011-2012

Ma et al. (2014) gives a population estimate of 80 individuals, based on two records of 70-100 individuals in the last three years and another three records of less than 30 individuals. Actual population size probably smaller.

Gaoligong Mountains Range

Ma et al. 2014

Group affiliation: C2

Record status: interview (2011); last record (provisional) 2011

More than 100 individuals in 1986, 80-100 individuals in 2011. Ma et al. (2014) gives a population estimate of 80-100 individuals. Actual population size probably smaller.

Gaoligong Mountains Range

Ma et al. 2014

Group affiliation: C3

Record status: interview (2011); last record (provisional) 2011

One records with 15-16 individuals and another one with 100 individuals in 2011. Ma et al. (2014) gives a population estimate of 50 individuals. Actual population size probably smaller.

Gaoligong Mountains Range

Ma et al. 2014

Group affiliation: C4

Record status: interview (2011-2012); last record (provisional) 2011-2012

Two records of 70-80 individuals in recent five years. Ma et al. (2014) gives a population estimate of 70 individuals. Actual population size probably smaller.

Gaoligong Mountains Range

Ma et al. 2014, Yang et al. 2016

Group affiliation: C5, Luoma

Record status: interview (2011-2012); camera trap & direct sighting (2015); last record (confirmed) 2015

200-300 individuals in 1973 and 30-40 individuals in recent two years. Ma et al. (2014) gives a population estimate of 30-40 individuals. Based on camera trap photos and direct sightings (Figure 20), Yang et al. (2016) tentatively estimate the population size at >70 individuals.

Gaoligong Mountains Range

Ma et al. 2014

Group affiliation: C6

Record status: interview (2011-2012); last record (provisional) after 2000

More than 30 individuals in 1980s. Three interviewees reported 15 individuals after 2000. Ma et al. (2014) gives a population estimate of 20 individuals. Actual population size probably smaller or population extinct.

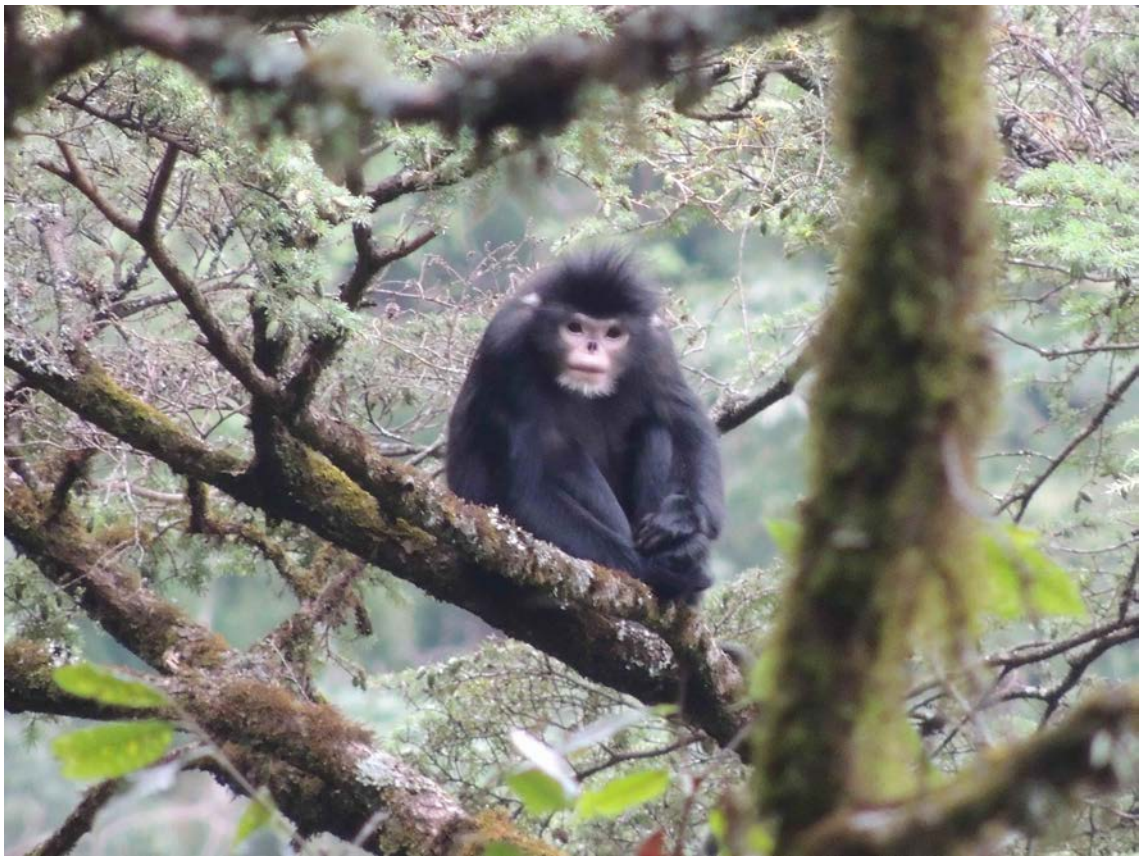

Figure 20. Male snub-nosed monkey at Luoma (C5). Photo: Dong Shaohua.

Gaoligong Mountains Range

Ma et al. 2014

Group affiliation: C7

Record status: interview (2011-2012); last record (provisional) 1983

30-40 individuals in 1983, but no recent records. Ma et al. (2014) gives a population estimate of 30 individuals. Actual population size probably smaller or population extinct.

Gaoligong Mountains Range

Long et al. 2012, Li et al. 2014, Ma et al. 2014, Chen et al. 2015

Group affiliation: C8, Pianma

Record status: interview (2011-2012), camera trap & direct sighting (2013-2014); last record (confirmed) 2014

Long et al. (2012) reported 300 individuals in 2011. This was the first evidence for the occurrence of the species in China (Figure 21). Ma et al. (2014) gives a population estimate of 100-200 individuals based on information from rangers that reported a little more than 100 individuals. 80 individuals were reported by Li et al. (2014). 90 individuals were identified by camera trap photos in 2013-2014 (Chen et al. 2015).

Figure 21. First photograph of *R. strykeri* in China at the Pianma site (C8). Photo: Liu Pu, taken on October 16, 2011.

Gaoligong Mountains Range

Ma et al. 2014

Group affiliation: C9

Record status: interview (2011-2012), last record (provisional) 2008

10-20 individuals in 2008. Ma et al. (2014) gives a population estimate of 20 individuals. Actual population size probably smaller or population extinct.

Gaoligong Mountains Range

Ma et al. 2014

Group affiliation: C10

Record status: interview (2011-2012), last record (provisional) 1980s

Two records with less than 10 individuals in 1980s. Ma et al. (2014) gives a population estimate of 10 individuals. Actual population size probably smaller or population extinct.

APPENDIX B – IUCN RED LIST CRITERIA

… for "Critically Endangered (CR)", "Endangered (EN)" and "Vulnerable (VU)" species (IUCN 2001)

CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing an extremely high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥ 90% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:

    (a) direct observation

    (b) an index of abundance appropriate to the taxon

    (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

    (d) actual or potential levels of exploitation

    (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥ 80% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of the following:

    (a) direct observation

    (b) an index of abundance appropriate to the taxon

    (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

    (d) actual or potential levels of exploitation

    (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

3. A population size reduction of ≥ 80%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of the following:

    (b) an index of abundance appropriate to the taxon

    (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

    (d) actual or potential levels of exploitation

    (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥ 80% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes

may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of the following:

(a) direct observation

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 100 km^2, and estimates indicating at least two of a-c:

a. Severely fragmented or known to exist at only a single location.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence

(ii) area of occupancy

(iii) area, extent and/or quality of habitat

(iv) number of locations or subpopulations

(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence

(ii) area of occupancy

(iii) number of locations or subpopulations

(iv) number of mature individuals.

2. Area of occupancy estimated to be less than 10 km^2, and estimates indicating at least two of a-c:

a. Severely fragmented or known to exist at only a single location.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence

(ii) area of occupancy

(iii) area, extent and/or quality of habitat

(iv) number of locations or subpopulations

(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence

(ii) area of occupancy

(iii) number of locations or subpopulations

(iv) number of mature individuals.

C. Population size estimated to number fewer than 250 mature individuals and either:

1. An estimated continuing decline of at least 25% within three years or one generation, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):

(a) Population structure in the form of one of the following:

(i) no subpopulation estimated to contain more than 50 mature individuals, OR

(ii) at least 90% of mature individuals in one subpopulation.

(b) Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 50 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or three generations, whichever is the longer (up to a maximum of 100 years).

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a very high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥ 70% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:

(a) direct observation

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥ 50% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of the following:

(a) direct observation

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

3. A population size reduction of ≥ 50%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of the following:

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥ 50% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of the following:

(a) direct observation

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 5,000 km^2, and estimates indicating at least two of a-c:

a. Severely fragmented or known to exist at no more than five locations.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence

(ii) area of occupancy

(iii) area, extent and/or quality of habitat

(iv) number of locations or subpopulations

(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence

(ii) area of occupancy

(iii) number of locations or subpopulations

(iv) number of mature individuals.

2. Area of occupancy estimated to be less than 500 km^2, and estimates indicating at least two of a-c:

a. Severely fragmented or known to exist at no more than five locations.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence

(ii) area of occupancy

(iii) area, extent and/or quality of habitat

(iv) number of locations or subpopulations

(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence

(ii) area of occupancy

(iii) number of locations or subpopulations

(iv) number of mature individuals.

C. Population size estimated to number fewer than 2,500 mature individuals and either:

1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):

(a) Population structure in the form of one of the following:

(i) no subpopulation estimated to contain more than 250 mature individuals, OR

(ii) at least 95% of mature individuals in one subpopulation.

(b) Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 250 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years).

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥ 50% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible AND understood AND ceased, based on (and specifying) any of the following:

(a) direct observation

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥ 30% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of the following:

(a) direct observation

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

3. A population size reduction of ≥ 30%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of the following:

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥ 30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of the following:

(a) direct observation

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 20,000 km^2, and estimates indicating at least two of a-c:

a. Severely fragmented or known to exist at no more than 10 locations.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence

(ii) area of occupancy

(iii) area, extent and/or quality of habitat

(iv) number of locations or subpopulations

(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence

(ii) area of occupancy

(iii) number of locations or subpopulations

(iv) number of mature individuals.

2. Area of occupancy estimated to be less than 2,000 km^2, and estimates indicating at least two of a-c:

a. Severely fragmented or known to exist at no more than 10 locations.

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence

(ii) area of occupancy

(iii) area, extent and/or quality of habitat

(iv) number of locations or subpopulations

(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence

(ii) area of occupancy

(iii) number of locations or subpopulations

(iv) number of mature individuals.

C. Population size estimated to number fewer than 10,000 mature individuals and either:

1. An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):

(a) Population structure in the form of one of the following:

(i) no subpopulation estimated to contain more than 1,000 mature individuals, OR

(ii) all mature individuals are in one subpopulation.

(b) Extreme fluctuations in number of mature individuals.

D. Population very small or restricted in the form of either of the following:

1. Population size estimated to number fewer than 1,000 mature individuals.

2. Population with a very restricted area of occupancy (typically less than 20 km^2) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period.

E. Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

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