DIMINISHING SPECTACLES: ADDRESSING THE GLOBAL DECLINE OF ENDANGERED PHAYRE'S LANGURS

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ABSTRACT

Phayre's langur (*Trachypithecus phayrei*) is one of the least-studied Asian colobines. We reviewed a wide range of published and unpublished literature to gather existing information on their taxonomy, distribution, natural history, behavioral ecology, population status, associated threats, extirpations, and knowledge gaps for conservation. This predominantly arboreal species is restricted to diverse forest habitats in eastern Bangladesh, northeast India, and western Myanmar. Many of the habitats are already small, fragmented, and isolated which may limit further any genetic exchange. The langur has been listed as a globally Endangered species and its population is suspected declined by 50% population over the last three generations. In Bangladesh and India, several isolated small populations have already been extirpated due to habitat loss and extensive hunting. Illegal trading for live animals, electrocutions, and collision with vehicles are causing a direct loss of the population. The species' population in Myanmar is not known well but facing additional threats of using its gallstones for traditional medicine. Its eco-ethological information is scanty and limited to short-term observational studies. We highlighted required studies on the population status, spatial-scale threats, and population-level genetics in their whole distribution range to develop a precise conservation action plan.

Keywords: *Trachypithecus phayrei*, Leaf monkey, Colobine, Endangered species, conservation priorities.

Introduction

In the past 150 years, the human population has fourfold which is correlated to natural resource use and the ongoing mass extinction of global biodiversity (Pörtner et al., 2021). Biodiversity loss catalyzes climate change that is threatening millions of species and their habitats in return (IPBES, 2019; IPCC, 2022). Terrestrial forests are biodiversity hubs and home to 68% of the mammalian species, many of which are highly threatened with extinction due to large-scale deforestation, fragmentation, and myriad anthropogenic disturbances in recent decades (FAO and UNEP, 2020). More specifically, our closest biological relatives the nonhuman primates (hereafter, primates) are vital mammalian components in tropical forest ecosystems where they contribute to forest

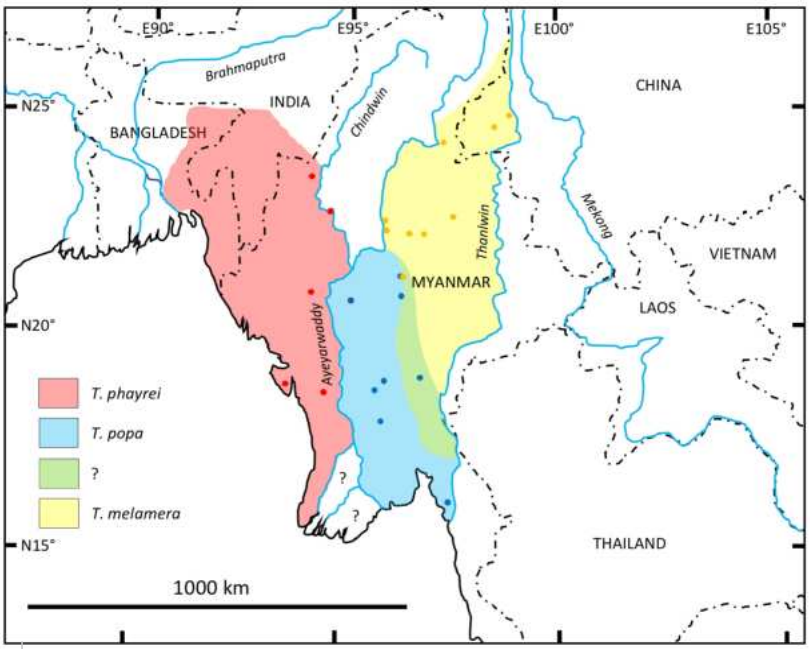

Fig 1 : *The distribution range of Phayre's langur (Trachypithecus phayrei), Popa langur (T. popa), and Shan State langur (T. melamera) following the revised taxonomy. Map by Christian Roos.*

regeneration and maintain ecosystem health (Estrada et al., 2017). They also play important roles in the livelihoods, cultures, and religions of many societies and offer unique insights into human evolution, biology, behavior, and the threat of emerging diseases (Estrada et al., 2017). Unfortunately, over 60% of the primate species are now threatened with extinction and over 75% have declining populations due to the continuous loss of forest habitat, hunting and trapping, logging, pollution, and climate change (Estrada et al., 2017).

Asia is home to 131 taxa of primates and about two-thirds of these are threatened with extinction (IUCN, 2023). In particular, the colobines are one the most threatened group of primates in Asia (IUCN, 2023). Containing 22 species now, *Trachypithecus* is the most speciose and geographically dispersed genus among Asian colobines (Roos et al., 2020). The updated assessments revealed that 96% of the *Trachypithecus* species are listed under threatened categories in the IUCN Red List of threatened species, of which, 18% species are Critically Endangered, 55% Endangered, 23% Vulnerable, and only 4% are Near Threatened (IUCN, 2023). The majority of these species occur in Southeast Asian countries while only three species in South Asian countries– Bangladesh and India (Roos et al., 2014). In common, these two countries hold strong populations of globally threatened Phayre's langurs *T. phayrei* and Capped langurs *T. pileatus* and India has one more globally threatened colobine named Golden langur *T. geei*. Phayre's langur is one of the least-studied Asian colobines in terms of ecology, behavior, genetics, and systematics (Roos et al., 2020). This article summarizes the existing information on the poorly known Phayre's langurs, focusing on their population decline over the last few decades.

Methodology:

We have reviewed a wide range of literature that includes peer-reviewed articles, books, technical reports, and both published and unpublished doctoral theses available in different online sources such as Web of Science, Google Scholar (https://scholar.google.com/), Researchgate (https://www.researchgate.net/), websites of journals, authors' personal archives, and specialized

Fig 2 : *A male (left) and a female Phayre's langur with an infant in northeast Bangladesh. Photos by Tanvir Ahmed and Sabit Hasan.*

databases (i.e., Primate Lit, University of Wisconsin: http://primatelit.library.wisc.edu/) (Gamalo et al., 2020, Stevenson et al., 2010). General keywords were "Phayre's langur", "Phayre's leaf Monkey", "*Trachypithecus phayrei*", "*Presbytis phayrei*" "Bangladesh", "India" and "Myanmar" to initially screen the literature. In terms of topic-specific enhanced searches, we used specific keywords for topics such as "ecology", "taxonomy","population", "distribution", "threats", and "conservation". Besides, we tracked the references cited in the published literature to retrieve articles that were not indexed in any of these databases. Studies conducted outside of Bangladesh, India, and Myanmar were not included in this review due to the recent update in taxonomy (described below). For this, the methods and supplements of the specific papers were read thoroughly. The conservation priorities mentioned in this article were summarized based on the recommendation sections of the respective literature. As the aim of this article is to provide a general overview of the current status of the wild Phayre's langurs, we avoided topics that are related to captive populations and not directly associated with our aim.

Taxonomy and updated distribution of the Phayre's Langur:

In the past, Phayre's langur (*T. phayrei*) was considered a subspecies of *Presbytis obscurus* (Groves, 2001; Rowe and Myers, 2016; Roos et al., 2020; Chetry and Ahmed, 2021). Later, Groves (2001) elevated it to a species with three subspecies (*T. p. phayrei, T. p. crepuscula* and *T. p. shanicus*), and three named subspecies were well differentiated morphologically, but the molecular association wasn't examined including all sister taxa. At that time, Phayre's langur was believed to be distributed widely in South and Southeast Asian countries: Bangladesh, China, India, Lao People's Democratic Republic, Myanmar, Thailand, and Vietnam (see details in Bleisch et al., 2020). However, Mittermeier et al. (2013) designated *T. crepuscula* as a species based on the findings of several other taxonomic investigations and left *T. phayrei* with two other subspecies.

Finally, Roos et al. (2020) resolved the taxonomy based on a robust mitogenomic species-level phylogeny of the genus *Trachypithecus*. The research elevated two remaining subspecies (*T. p. phayrei* and *T. p. shanicus*) to species status (*T. phayrei* and *T. melamera*) and described a new taxon named Popa Langur (*T. popa*) from the historical distribution range of Phayre's langur (Roos et al., 2020). The three species clades have diverged about 1 (0.79–1.13) million years ago and the shanicus is a synonym of previously known melamera (Roos et al., 2020). The revised taxonomy revealed that the distribution range of Phayre's langur is restricted to eastern Bangladesh, northeastern India (Assam, Tripura, and Mizoram states), and western Myanmar (west of Ayeyarwaddy and Chindwin rivers) (Figure 1).

Morphological Characters:

Phayre's langur has a blackish face with identical white eye rings and a white muzzle (Figure 2). The lips are pinkish-white. There is a short but prominent crest on the head. The coat color is dark grey and white ventrally. The hands and feet are slightly darker. The tail is longer than the body. Males and females are alike and often females are slightly larger than males. Infants have straw to yellow-colored fur for a few weeks and then the pelage begins to change to grey (Rowe and Myers, 2016). Adult males can be distinguished from females by ocular markings: in females, the white ocular rings around the eyes bend inwards toward the nose causing more of a black triangular shape while in males, the ring is often uniformly width (Bhattacharya and Chakraborty, 1990; Cantwell, 2011). In both sexes, there can be variable blackish shades on the upper side of the ocular ring (Tanvir Ahmed, pers. observation).

***Fig 3**: Two Phayre's langur individuals resting in Lawachara National Park, Bangladesh, (a) the erected penis of a male before masturbation and (b) the male rubbing the penis body with his right hand. Photo by Md. Shalauddin.*

The head-body length of Phayre's langur is 420–600 mm while the tail is 720–800 mm depending on the sex and the body weight ranges from 5.7 to 9.1 kg (Rowe and Myers, 2016). However, it could be somewhat difficult to identify Phayre's langur visually from the members of the *T. obscurus* group but their distribution is separated by major barriers such as rivers (details in Roos et al., 2020).

Life History and Social Organization:

Phayre's langurs form both single-male multifemale and multimale-multifemale complex social groups and there is a complex hierarchy among males (Ahmed et al., 2021; Rowe and Myers, 2016). Solitary males disperse and very rarely form an all-male band (Kabir, 2002). The group size ranges from 4 to 26 individuals with a mean group size of about 11 individuals in the northeastern forests of Bangladesh (Ahmed et al., 2021). One adult male usually leads the group and mates with multiple adult females in the group. Overall, the adult male and adult female ratio was 1: 1.63 in northeast Bangladesh (Ahmed et al., 2020). The age of females at first birth is unknown and considering sister taxa, it could be 3 to 5 years. The gestation period is about 150-180 days (Kabir, 2002) and the birth-to-weaning period is about 310 days (Rowe and Myers, 2016). The interval between births ranges from 15 to 18 months in Tripura in northeast India (Gupta, 1994, 1996; Kabir, 2002). Food resources and other associated factors may have a significant influence on their birth seasonality /peaks (Gupta, 1996; Kabir, 2002).

Recent observations suggest that like humans, males of Phayre's langur can perform masturbation to ejaculate (Figure 3; Shalauddin et al., 2021). However, the cause of performing such auto-sexual behavior is still unclear but may have evolved to sire offspring from the coincidence of sexual desire and lack of sexual opportunity (Shalauddin et al., 2021). Masturbation can also lead to a hormonally induced relaxation that reduces aggression and may have importance in such social living primates (Thomsen and Sommer, 2015). In some cases, solitary Phayre's langurs can join groups of sympatric Capped langurs to form mixed-species groups and vice-versa (Kabir, 2002). Recently, several presumed hybrids between Phayre's and Capped langurs were identified and information on one of the presumed hybrids was recently reported from northeast Bangladesh (Al-Razi et al., 2022).

Behavioral Ecology and Feeding Habits:

Phayre's Langur is a predominantly arboreal species and totally depends on forests for feeding, resting, and sleeping. Within the distribution range, they live in primary and secondary evergreen, semi-evergreen, mixed moist deciduous forests, plantations, bamboo, and hill forests (Chetry and Ahmed, 2021; Mittermeier et al.,2013). It prefers dense forest cover and bamboo

thickets along hillsides and streams (Mittermeier et al., 2013).

Phayre's langurs are well-known to be highly folivorous (Mukherjee, 1982; Stanford, 1988; Gupta and Kumar, 1994; Gupta, 2001), and spend a good amount of their time foraging and feeding (Gupta, 1996; Naher et al., 2022). Early mornings and late afternoons are the peak foraging time for Phayre's langurs and they take rests by mid-day in the shady trees (Mittermeier et al., 2013; Naher et al., 2022). However, there are some variations in their overall activity budgets in different study sites in India and Bangladesh. For example, Gupta and Kumar (1994) studied a Phayre's langur group of 18 individuals in the Gumti Wildlife Sanctuary in Tripura state of India from 1989 to 1990 and found the species spent 34.9% of the daytime for feeding, 21.1% time for resting, 14.4% time for traveling and together 29.5% time in social grooming and playing. Kabir (2002) found that the species spent 34.1% of their active time in feeding, 46.2% time in resting, 12.3% time in traveling, and 7.4% time for other social activities from 1988 to 2000 in Rema-Kalenga Wildlife Sanctuary in northeast Bangladesh. Based on the behavioral observations in Satchari National Park only during a winter season between 2017 and 2018, Naher et al. (2022) recently presented that Phayre's langurs spent 40.7% of the observed time in foraging and feeding, 31.8% time in traveling, 18.3% time in resting, 7.8% time in social grooming, and the remaining time (1.4%) was spent on playing behavior. Hence, it is likely that there might be an influence of the availability of food resources, seasonality, and group structure on their activity budgets that demands further studies.

Fig 4: *Phayre's langur eating figs at Lawachara National Park. Photo by Tanvir Ahmed.*

As a predominantly folivorous primate, considering the seasons and habitat types, Phayre's langurs consume leaves in approximately 50% (range: 46–58%) of their diet (Stanford, 1988; Gupta and Kumar, 1994; Kabir, 2002; Naher et al., 2022). There is a variation in the amount of leave consumption among core forest habitats, forest adjoining vegetation, and monoculture plantations (Patari et al., 2022). Leave consumptions were higher in quantity outside the forests and in monoculture plantations: 76.39% and 68.75%, respectively (Patari et al., 2022). Phayre's langur prefers young leaves over mature leaves and the main sources of young leaves reported are *Gmelina arborea, Acacia mangium., Erytrhina* sp., *Albizia procera, A. chinensis, Melocanna beccifera, Bambusa tulda, Toona ciliata, Chukrasia tabularis, Tectona grandis, Terminalia catappa, Ilex godajam,* etc. in northeast Bangladesh (Kabir, 2002; Aziz and Feeroz 2009). Other food items include fruits, flowers, sap, gum, petioles, bamboo shoots, and some animal matter (Aziz and Feeroz, 2009; Mittermeier et al., 2013; Naher et al., 2022). Fruits and seeds account for about one-fifth to one-third of all food consumption in Phayre's langurs in northeast Bangladesh (Stanford, 1988; Naher et al., 2022).

Fig 5: *Collection of bamboo from the Rajkandhi Reserve Forest and a monoculture plantation in Atora Hill Reserve Forest in northeast Bangladesh. Photos by Tanvir Ahmed and Shimul Nath.*

Seasons influence dietary choice and leave consumption was found higher in December (76% of the total diet), fruits and seeds are preferred in June (57%), and flowers and buds in April (41%) (Mittermeier et al., 2013). Figs and Bamboo are important food items year-round (Figure 4). Kabir (2002) found that Phayre's langurs shared 53.7% (n=51 species) of the plant species with sympatric Capped langurs (*T. pileatus*). Phayre's langurs used a feeding height of 0 to 30 meters and the most-used height was between 10 to 20 meters (Kabir et al., 2002; Gupta, 1994).

Population Declines over the Decades:

There is no recent estimate of the global population of Phayre's Langur available but it is suspected to have declined by 50% in the last three generations (1 generation = 12 years; Chetry and Ahmed, 2021). In Bangladesh, Phayre's Langurs are restricted to a few small fragmented and extremely isolated forest patches in the eastern regions (Ahmed et al., 2020; IUCN Bangladesh, 2015). In the early 80s, about 1300 individuals of Phayre's Langur were known to occur in the country and about 80% of the population is believed to have declined in the last few decades due to large-scale habitat destruction and fragmentation (Figure 5; Gittins and Akonda, 1982; IUCN Bangladesh, 2015). Our recent effort made a hopeful discovery of about 400 individuals of Phayre's langur in northeastern forests in Bangladesh. However, very limited information on its population is available from the southeastern forests where several local extinctions of small populations already have taken place due to extensive hunting pressures (Hasan et al., 2022). There is a serious lack of scientific knowledge regarding their survival in the fragmented forest patches in Bangladesh and other range countries. Increased live trading of animals, electrocution, and vehicle collisions in recent years are also directly contributing to the ongoing decline of langur populations in Bangladesh (Ahmed et al., 2020). Based on these facts and a potential inbreeding risk due to habitat loss and fragmentation, Phayre's langur has been listed as Critically Endangered in Bangladesh (IUCN Bangladesh, 2015).

The Indian population of Phayre's langur is also small and isolated in a few locations where they face similar threats, perhaps, in varied intensity (Chetry and Ahmed, 2021; Choudhury, 2001; Molur et al., 2003). Several forests, especially in Tripura and Assam still harbor some population but the recent loss of forest habitats, increased fragmentation, illegal hunting, and electrocution are likely threatening the populations to an unknown declining rate (Figure 6; Singh and Choudhury, 2021; Gupta, 2001; Choudhury, 2001;

Chetry and Ahmed, 2021). Already, several isolated small populations have extirpated in India due to extensive hunting pressures and habitat loss (Bleisch et al., 2020). Based on the direct sighting of 1134 individuals under 46 troops (Bose, 2003, 2005; Parida and Solanki, 2020; Singh and Choudhury, 2020), the total population in India was estimated to be about 1,200 individuals (Chetry and Ahmed, 2021). However, it requires recent data to understand the greater picture of the Phayre's langur "status" in India. Published information on the Phayre's langur population is not available from Myanmar (Chetry and Ahmed, 2021) where hunting is one of the major causes of population decline (Mittermeier et al., 2013). Phayre's langurs were reported to be commonly hunted for their gallstones to produce traditional medicine in Myanmar (Mittermeier et al., 2013). Climate change has had a significant impact on declining the habitat quality of primates (Estrada et al., 2017). A recent assessment suggests that the species of the genus *Trachypithecus* have a greater sensitivity to heat which may make them vulnerable to climate change (Kraus and Strier, 2022).

***Fig 6**: Confiscated juvenile Phayre's langur while trafficking illegally from southeast Bangladesh in August 2023 (A) and two carcasses of electrocuted Phayre's langurs in northeast Bangladesh (B and C). Photos by Khurshed Alam, abnews24.com and prothomalo.com.*

Setting Conservation Priorities:

All over the distribution range, Phayre's langur has been a legally protected species over the last few decades and it occurs in a number of protected areas (Mittermeier et al., 2013; Chetry and Ahmed, 2021) but the implementation of laws may be poor. During the mid-80s, Eudey (1987) regarded Phayre's langur as a 'vulnerable' species with a high conservation priority rating based on various criteria including degree of threat, taxonomic uniqueness, and association with other threatened primates. However, the overall advances in the research and conservation initiative for Phayre's langur are very limited, much baseline data is still missing and some available information is already outdated. Hence, the species demands an assessment of their current population status, inbreeding risks, and viability of small populations in their whole distribution range to develop a precise conservation and management action plan. Urgent programs are required to mitigate hunting, trading, habitat loss, and fragmentation by implementing laws, engaging local communities, environmental education, and building capacity. Habitat connectivity can also be increased through forest restorations, increasing corridors, and transboundary conservation measures. Regarding climate change's impact on the species and their habitats, we suggest developing projections on the habitat suitability in the future climate scenario based on ground truthing data and fixing priorities. In Bangladesh, we already have started conducting the population surveys and conservation education program for Phayre's langur in mid-2017 (Figures 7 and 8), and further studies on their population genetics in the face of fragmentations are underway. The Wildlife Crime Control unit of the

Bangladesh Forest Department has been activated to mitigate illegal trading and multiple conservation projects are being conducted in some habitats. A similar approach can also be initiated in Myanmar and India if it has not taken place already. Overall, the formation of a working group with conservation specialists, scientists, and the country's legal authorities will be beneficial to determining conservation pathways both at national and transboundary levels.

Fig 7: *Population survey of Phayre's langur following the streamline at Rajkandi Reserve Forest in northeast Bangladesh in mid-2018. Photo by Sajib Biswas.*

Conclusion:

Although there is no precise estimate, the total population of the globally Endangered Phayre's

Fig 8: *Engagement of local communities for Phayre's langur conservation in northeast Bangladesh during 2018. Photos by Phayre's langur conservation initiatives in Bangladesh project.*

langur is likely small due to going through a serious decline over the last few decades. In particular, the small populations are on the verge of extinction which demands urgent conservation initiatives. Much baseline information including their current population status, ecology, behavior, and site-specific threats is missing. To develop a precise conservation plan for this species, such information is a prerequisite. This article highlighted some measures to facilitate the conservation of Phayre's langurs within their whole distribution range.

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Tanvir Ahmed is a passionate primatologist and an enrolling doctoral student at the German Primate Center, Germany under a DAAD scholarship. His recent research focuses on the impact of habitat loss and fragmentation on the population-level genetics of Phayre's and Capped langurs in Bangladesh. He also contributes/contributed to several research and conservation projects on the Gibbons, Lorises, and Macaques. Tanvir with 28 scientists described a new primate species– Popa Langur (*T. popa*)– from Myanmar in 2020.He serves as a member of the IUCN SSC Primate Specialist Group (PSG), and an assistant to the Editors of the Asian Primates Journal published by PSG.

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