

PHOTOGRAPHIC EVIDENCE OF THE KASHMIR GREY LANGUR *Semnopithecus ajax* IN PAKISTAN WARRANTS DETAILED TAXONOMIC ASSESSMENT OF LANGURS ACROSS THE HIMALAYAS

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ABSTRACT

The Himalayan langur (*Semnopithecus* species complex) has largely been overlooked by research and conservation in Pakistan. Due to a lack of information, as well as taxonomic disagreement, our knowledge of the Himalayan langur population in Pakistan and its taxonomic standing remains elusive. Previously, the langur population in Pakistan was assigned to *S. schistaceus*. However, we report here the first photographic evidence of *S. ajax* in Pakistan, based on comparisons of photographs from Pakistan with images of *Semnopithecus* species from Nepal and India. A recent proposal to consider *S. ajax* synonymous with *S. schistaceus* would have several implications from a conservation perspective. We also identify a list of threats to *S. ajax* conservation in Pakistan, such as habitat degradation, human disturbance, and activities that act as potential drivers of human-langur conflict. We conclude that *S. ajax* population in Pakistan is facing considerable anthropogenic threats with limited conservation strategies in place at the national level.

Keywords: Anthropogenic threats, Azad Jammu and Kashmir, conservation, Khyber Pakhtunkhwa, taxonomic assignment

INTRODUCTION

The “Himalayan langur” is a species-complex that represents the northernmost population of the grey langurs (*Semnopithecus* spp.), distributed across the Himalayan regions of India, Nepal, parts of Bhutan, and Pakistan (Pocock, 1939; Sugiyama, 1976; Khanal et al., 2018; Bagaria et al., 2020), but their taxonomy remains unresolved. Debate regarding the species or subspecies status of Himalayan langurs and their current distribution across the countries of the Indian subcontinent is ongoing, and to date, attempts to establish a “definitive” ruling on the taxonomic status and conservation action plans for members of this complex, especially for Pakistan, remain incomplete (Minhas et al., 2012).

Based on morphology, three species of Himalayan langurs have been proposed, namely *Semnopithecus schistaceus* Hodgson (1840), *Semnopithecus hector* Pocock (1928), and *Semnopithecus ajax* Pocock (1928) (Groves, 2001). This taxonomic classification scheme has been adopted by the International Union for Conservation of Nature (hereafter IUCN) (Kumar et al., 2020; Singh & Kumar et al., 2020; Singh & Kumara et al., 2020), and we are adhering to this classification in our study. *Semnopithecus ajax* is distinguished from *S. schistaceus* by its massive size and darker-coloured fore and hind limbs, the white tip on its tail, and a tail carriage while walking on the ground in which the tail arches over its back and curves toward the head (Groves, 2001). *Semnopithecus ajax* is listed as

Endangered (Kumar et al., 2020), mainly because this species has only been reported to occur in the Chamba Valley in Himachal-Pradesh, India, and the Kishtwar Valley in Jammu-Kashmir and parts of Pakistan (Minhas et al., 2012; Kumar et al., 2020), which is the smallest distribution range of the three Himalayan taxa. In a recent study using morphological, ecological, and genetic data, Arekar et al. (2021) concluded that the Himalayan langur populations belong to a single, monotypic species, which would mean that *S. ajax* and *S. hector* should be considered synonymous with *S. schistaceus*. However, their phylogenetic hypothesis was based on a limited sample, mainly from the Indian Himalayas, and relied on a small mitochondrial DNA fragment (746 base pairs (bp) in the *CYTb* gene). The study also used ecological niche modeling to investigate differences among the langur populations, but could only differentiate the Himalayan population from that of peninsular India (Arekar et al., 2021). However, the modeling approaches used were not designed to assess niche differentiation among the Himalayan langur populations or proposed species of langurs from the Himalayas. Most importantly, populations of Himalayan langur from Pakistan were not included in this phylogenetic analysis.

Due to taxonomic disagreement and a lack of information from Pakistan regarding its distribution range, the occurrence of *S. ajax* in Pakistan has been questioned (Kumar et al., 2020; Singh et al., 2020b), and it is not clear whether multiple species or subspecies of langurs occur in Pakistan. To date, phylogenetic and morphological analyses have not included data collected from the Pakistan population of Himalayan langurs that would allow for comparison with those from other countries. As such, the limited knowledge about the taxonomy of "Himalayan langurs" in Pakistan has impeded conservation planning in the nation. Here, we provide morphological information for Himalayan langurs from Pakistan using photographic data, compare the images with images of Himalayan langurs from India and Nepal, and identify current conservation challenges affecting the langur population in Pakistan.

METHODS

Selection of study sites

The study area is a part of the greater Himalayan range located in Pakistan's northernmost region, bounded by latitudes 31°30'-37°00'N and longitudes 69°00'-77°30'E. The annual mean temperature in the region is recorded at 12.6°C, and the total annual rainfall

amounts to 893 mm (Ali et al., 2021). Heavy snowfall occurs in January (Ali et al., 2022). The topography, climate, geological features, types of rocks, and soil characteristics have a significant impact on vegetation in the Himalayas, which is typical of mountainous terrains (DiPietro et al., 2021). Based on these factors, Himalayan vegetation can be classified into broad types (Singh & Thadani, 2024). A wide variety of forest types are found in the Western Himalayas, ranging from tropical forest to alpine scrub, which in turn can be classified into seven major types, including Alpine Scrub, Sub Alpine Forests, Dry Temperate Forests, Moist Temperate Forests, Sub-Tropical Coniferous Forests, Sub Tropical (broad leaves) Forests, and Tropical Dry Deciduous Forests (Qamer et al., 2016). However, due to intense illegal logging, dense forests are now present only in remote areas. Some dominant plant species in the area include deodar *Cedrus deodara* (Roxb. ex D. Don) G. Don., blue pine *Pinus wallichiana* (A.B. Jacks.), fir *Abies pindrow* (Royle ex D. Don) Royle, walnut *Juglans regia* L., spruce *Picea smithiana* (Wall.) Boiss., Himalayan poplar *Populus ciliata* (Wall. Ex Royle) and maple *Acer caesium* (Wall. ex-Brandis) (Ali et al., 2017). A number of threatened mammal species are found in the area including Leopard *Panthera pardus* Linnaeus, Asiatic Black Bear *Ursus thibetanus* G. Cuvier and Rhesus Macaque *Macaca mulatta* Zimmerman (Ali et al., 2022).

We conducted several meetings with authorities to gather information on langur occurrence, possible threats, as well as recent sightings. We then conducted surveys and collected information on langurs from local wildlife watchers/foresters in previously reported locations (Minhas et al., 2018), and surveyed new sites based on information from local people. We conducted surveys from September 2021 to December 2022 at nine specific sites in Pakistan from the Khyber Pakhtunkhwa (KPK) Province (Table 1), including sites in the Mansehra District (Kaghan and surrounding valleys) and Kohistan District (Pallas Valley). We also conducted surveys in Machiara National Park and Leepa Valley in Azad Jammu Kashmir (AJK) state of Pakistan (Fig. 1). These sites span the potential distribution area of the langurs in the country (Minhas et al., 2018). During our study, we confirmed the presence of a previously unstudied population of this species complex in Punja Gali. This particular study site had not been investigated in prior research, including the study conducted by Minhas et al. (2018).

Data Collection

Once we selected sampling sites, we carried out

Table 1. Survey sites, locations, and elevations, number of people interviewed, and features of line transects. The number of troops observed and an estimated number of individuals per troop are also indicated.

Survey Sites	Location	Elevation (m)	Respondents	Transects	Transect length (km)	Troops (Individuals/troop)
Nadi Bungalow	34° 39.261'N 73° 21.558'E	2,482	6	1	1.7	2 (9, 5)
Malkandi/Oorni top	34° 38.086'N 73° 29.176'E	2,531	5	1	2	2 (4, 12)
Kamal Band Reserve Forest	34° 43.784'N 73° 29.258'E	2,671	6	1	1.5	2 (7, 10)
Manshi/Shrah Reserve Forest	34° 41.698'N 73° 27.128'E	2,443	5	2	1 & 1.8	1 (14)
Shogran/Seripaya	34° 63.98' N 73° 46.07'E	2,791	6	1	2	1 (8)
Punja Gali	34° 29.621'N 72° 53.691'E	2,831	8	2	1.6 & 2	1 (20)
Pallas valley	35°10.35' N 72° 99.99'E	2,824	5	1	2.3	2 (2, 3)
Machiara National Park	34° 34.707' N 73° 33.664'E	2,919	6	2	2 & 1.2	2 (12, 9)
Leepa Valley	34° 33.475' N 73° 53.043'E	2,964	3	1	1.5	1 (13)
Total			50	12	20.6	14 (128)

interviews with community members, line transect sampling to confirm the presence of langurs, and species characterization via photographs. First, community interviews were conducted with local village leaders, wildlife watchers, and forest patrollers, following the snowball sampling method (Newing et al., 2011). Official written permission was acquired from Pakistan's regional wildlife offices before conducting the study, and verbal informed consent was obtained from all participants. No subject identifiers (e.g., name, address) were collected from the participants. We started by showing photos of several monkeys found in the study area, including macaques (Maestriperi, 2010) and other distinct langur species found elsewhere. Whenever a respondent chose a langur that occurs in the area, we then asked for their opinion on its taxonomic classification (i.e., *S. ajax* or *S. schistaceus*) by showing several photos displaying visual variation between the species. The location, date, and estimated group size of the langurs were recorded if the interviewees could accurately describe and recognize *S. ajax* between pictures of different

species of primates they encountered. Based on the respondents' positive recognition of *S. ajax*, we carried out line transect sampling in habitats with low human disturbance (see below) to verify the accuracy of the information provided.

Line transects were established along the existing forest trails. Twelve transects spanning a cumulative total distance of ~26 km were surveyed (Table 1). Each transect was sampled only one day, once in the morning (08:00-11:00h) and again in the afternoon on return (13:00-17:00 h). The walking speed was approximately 1.2 km/h. When a langur individual or group was encountered, we recorded the time and GPS location (using a handheld Garmin eTrex 10 device), and counted the number of individuals sighted. Other parameters were recorded along the transect, such as the presence of possible conservation threats, categorized as "habitat degradation/deforestation", "human-primate conflict" (e.g., local farmers claiming crop foraging by langurs), or "human disturbance" (e.g., timber collection, tourism, and recent wildfires). For the "habitat degradation/deforestation" category,

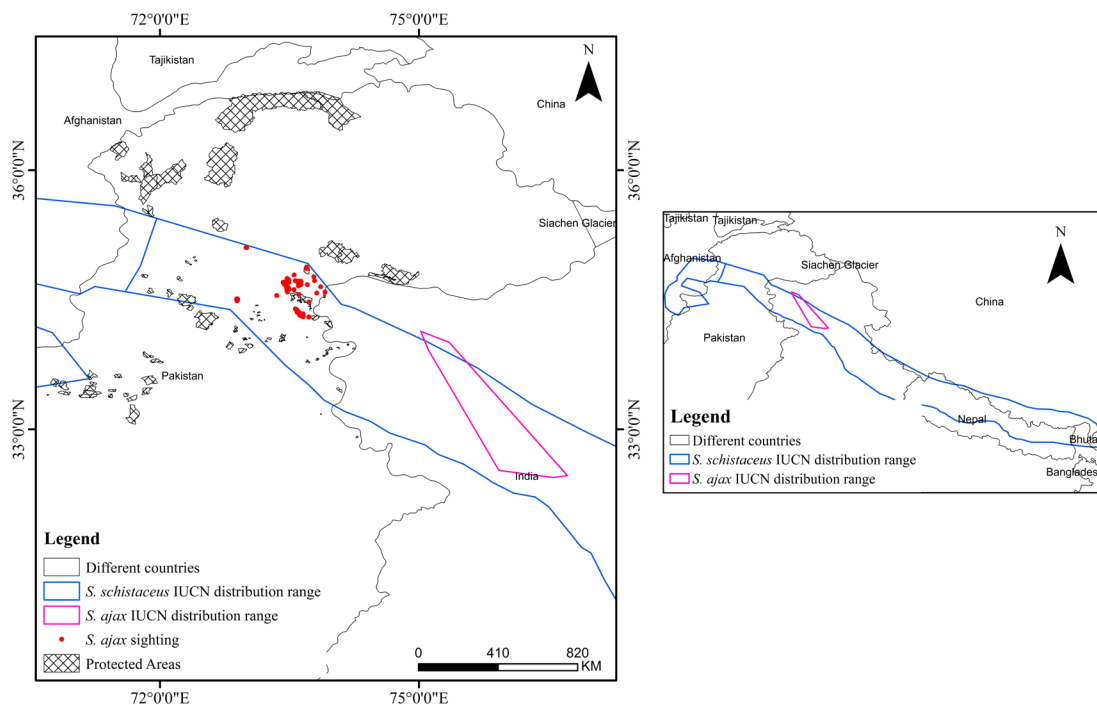


Fig. 1. Boundaries of Himalayan countries (in black), *Semnopithecus schistaceus* IUCN distribution range (in blue), *Semnopithecus ajax* IUCN distribution range (in pink), langur sighting and distribution (red dots) recorded at the field sites in Pakistan.

we visually assessed changes in forest cover, such as vegetation density, and identified instances of encroachment and land-use alterations (e.g., urban expansion, infrastructure development, mining, and agricultural expansion). For “human-primate conflict,” we directly observed instances of crop raiding by langurs and recorded local farmers’ reports of crop raiding. In the case of “human disturbance,” we directly recorded activities such as timber collection, tourism-related interactions, and recent wildfires based on our observations in the community and surrounding areas.

To document Himalayan langur morphology, we took photographs of the langurs whenever observed using a Canon 60D camera with a 75–300mm lens. Photos of five individuals from three geographically independent troops of langurs in Pakistan were used to compare the visual morphology of the taxon in the study area with those of langurs from other parts of the Himalayas (Fig. 2). For comparison, we used photographs of *S. hector* from the western lowlands of Nepal (385 m asl), *S. schistaceus* from Langtang National Park, central Nepal (3,200 m asl), and *S. ajax* from Chamba Valley, India (1,200 m asl).

RESULTS

In total, we conducted interviews with 50 individuals residing in areas identified as potential langur habitats. All were males and more than 18 years of age. All participants accurately recognized and described *S. ajax* in terms of its morphological characteristics and distinguished them from other primate species. The participants also shared information about the local area’s habitat and distribution range of langurs.

We encountered langurs through direct sightings on all line transects (Fig. 1). We counted 128 individuals from 14 distinct troops (Table 1). We photographed adults from two troops on 20 May 2022 (Troop 1 in Fig. 2D, and Troop 2 in Figs. 3 and 4). Two additional individuals from a third group (Troop 3) were photographed on 11 December 2022. Morphological differences were detected in langurs from Pakistan when compared with those photographed in Nepal and India (Fig. 2). For example, the *S. hector* individual (Fig. 2A) from lowland Terai of Nepal (385 m asl) has brown pelage throughout the body, a whorl of short white hairs on the head and a consistently brownish tail.

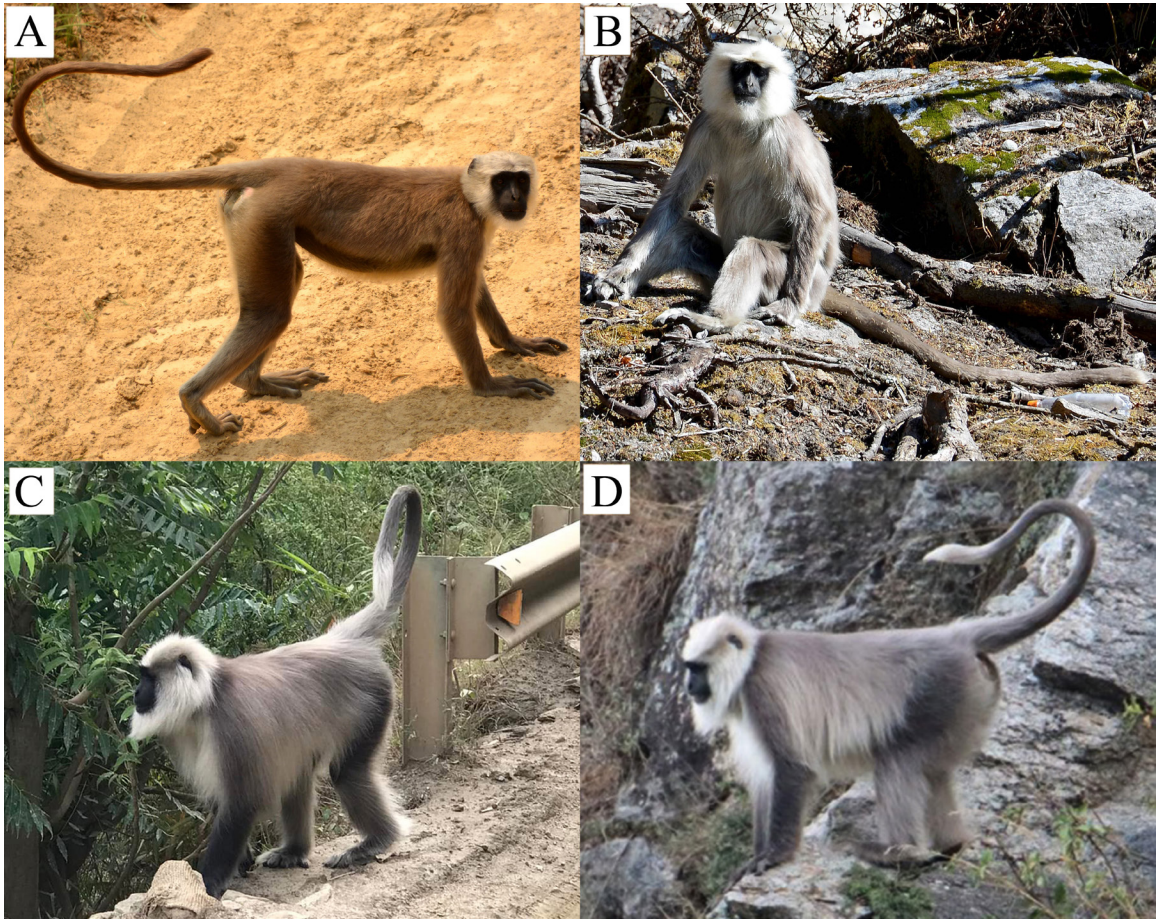


Fig. 2. Himalayan langurs from different locations. (A) *S. hector* from western lowland of Nepal (385 m asl) (Photo credit: Laxman Khanal); (B) *S. schistaceus* from Langtang National Park, central Nepal (3,200 m asl) (Photo credit: Randall C. Kyes); (C) *S. ajax* from Chamba Valley, India (1,200 m asl) (Photo credit: Sanjay Molur) and (D) langur from Pakistan (Photo credit: Abid Ali and Waheed). The langur from Pakistan (D) resembles the *S. ajax* from Chamba Valley in India.

The *S. schistaceus* individual (Fig. 2B) from Langtang National Park (3,200 m asl) in central Nepal is lighter in colour and has a brown tail except for a few white hairs on the tip. On the other hand, *S. ajax* from Chamba Valley, India (Fig. 2C) has a white tip on its tail like a paintbrush dipped in white paint, a bushy white face, and large body size, with dark hairs on its forearms. The individuals photographed in Pakistan (Fig. 2D) had a stronger resemblance to *S. ajax* from Chamba Valley, India, than to *S. schistaceus* from Nepal. For example, the langurs in Pakistan have large body sizes with dark hairs on their forearms, a white tip on their tails, and bushy white faces that differ from *S. hector* and *S. schistaceus*.

All of the respondents (n=50) reported that langurs are becoming rare and believed that they are declining

in response to the number of anthropogenic activities. Threats observed along the transects included massive deforestation, land conversion for agricultural purposes, and intense pressure from grazing. Regarding human-langur interactions, 78% of the respondents (n=39) mentioned that langurs occasionally foraged on their crops. Furthermore, evidence of habitat destruction, human disturbance from timber collection, wildfire damage, and land clearance through controlled burns were also recorded along all transects.

DISCUSSION

Among Himalayan langurs, *S. ajax* is listed as Endangered, but detailed information on its occurrence is doubtful in Pakistan (Kumar et al., 2020). Our findings indicate that 100% of the respondents



Fig. 3. Langur group at Kaghan Valley.



Fig. 4. Langur at Punja Gali.

(n=50) correctly identified *S. ajax* from a list of available species, suggesting that it is the predominant species in the region. Furthermore, we confirmed the species using direct sighting methods at all surveyed locations previously identified as potential habitats (Minhas et al., 2012; Mir et al., 2022), including a new small population in the Punja Gali reserve forest of District Mansehra.

Our results suggest that langur species in Pakistan are more similar in appearance to *S. ajax* than to *S. schistaceus*. For instance, langurs observed in Pakistan share characteristics with *S. ajax* individuals from the Chamba Valley, India, including a white-tipped tail, bushy white faces, and large body sizes with dark hairs on their forearms. In contrast, langurs resembling *S. schistaceus* from Nepal display lighter colouration and lack the distinctive features of *S. ajax*. This contradicts previous findings that considered *S. ajax* and *S. schistaceus* as a single taxon (Arekar et al., 2021). This research offers photographic evidence highlighting the distinctions in traits between *S. ajax* and *S. schistaceus*, as well as confirming the presence of *S. ajax* in Pakistan. There was no indication of *S. schistaceus* presence in the studied area. However, we cannot rule out the possibility that Pakistan may overlap with the ranges of both *S. ajax* and *S. schistaceus*. Therefore, further research is needed to clarify this question.

Regarding the conservation status of langurs in Pakistan, we reported a range of possible conservation challenges. Thousands of hectares of land are being transformed into agricultural areas, and expansive urbanization in the study area is altering habitat structure (Nabi et al., 2017). Illegal logging has also significantly impacted habitat and species distribution. For example, based on local people's perceptions, *S. ajax* was once prevalent in Pallas Valley; however, it has now almost disappeared. In some locations, local people reported that *S. ajax* lacks natural foods and forages in agricultural fields, which creates challenges for long-term coexistence with local farmers. Additionally, the habitat of *S. ajax* has been significantly altered and is under extreme visitor pressure owing to recent growth in tourism in northern Pakistan. The potential impacts of tourism on langur conservation deserve further investigation. Furthermore, poaching and hunting of wild animals, including langurs, for illegal trade as pets and body parts is a common practice in Pakistan. Despite the Endangered conservation status of *S. ajax*, most populations in Pakistan are found outside the country's protected area network.

Effective conservation planning in Pakistan involves a multifaceted approach that takes into account various factors, including habitat preservation, community engagement, and mitigation of human-primate conflict. Our suggestion for future molecular studies to clarify the taxonomic affinities of Himalayan langurs in Pakistan is driven by the aim of strengthening the scientific basis for conservation decisions. Nevertheless, it should only be considered in conjunction with these other critical components of conservation action. A strong information base is urgently needed to inform future conservation work since *S. ajax* is experiencing a rapid decline in the region. *Semnopithecus ajax* is probably restricted to a very small distribution range and is thought to be more rapidly declining than any other species of Himalayan langur.

To fully understand the taxonomy of the Himalayan langur, it is recommended that a detailed taxonomic study, employing phylogenetic and morphologic analyses, be conducted across the Himalayas, including Pakistan. Additionally, there is no ongoing conservation-related research at a national level for this species. Therefore, we strongly recommend immediate conservation action to help mitigate the many anthropogenic pressures threatening this population.

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