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COMMUNICATION

A NEW REPORT ON MIXED SPECIES ASSOCIATION BETWEEN NILGIRI LANGURS *SEMNOPITHECUS JOHNNII* AND TUFTED GREY LANGURS *S. PRIAM* (PRIMATES: CERCOPITHECIDAE) IN THE NILGIRI BIOSPHERE RESERVE, WESTERN GHATS, INDIA

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A new report on mixed species association between Nilgiri Langurs *Semnopithecus johnii* and Tufted Grey Langurs *S. priam* (Primates: Cercopithecidae) in the Nilgiri Biosphere Reserve, Western Ghats, India

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Abstract: Phylogenetic conservatism or rapid anthropogenic habitat modifications could increase the incidences of interspecific associations of Hanuman and Nilgiri langurs (Family: Cercopithecidae, subfamily: Colobinae) in the southern Western Ghats. Opportunistic surveys were conducted at the Silent Valley National Park, Kerala and around Devimalai Ghats, Tamil Nadu for Tufted Grey-Nilgiri Langur association. Based on the observations from Researchers, field assistants, forest staff, and local people, the data in terms of the time of the sighting, number of individuals, phenotypes of individuals, and the time the interaction lasted, were recorded. The study reports data on a troop of Nilgiri Langurs (N=13) around O Valley tea estate at Devimalai Ghat, Gudalur, Tamil Nadu with some hybrid looking individuals and a Tufted female Grey Langur amongst them. A total of six and two uni-male troops of Nilgiri Langurs and grey langurs respectively with Tufted female Grey Langurs, and aberrant coat colored infants observed at the Neelikkal section of Silent Valley National Park are also reported. The study reasonably speculates that there could be more such locations in the southern western ghats and emphasizes the need for more systematic surveys to understand and explore the ecology, behavior, molecular, and other likely factors contributing to the conservation of vulnerable Nilgiri langur (*Semnopithecus johnii*) populations.

Keywords: Colobines, Coromandel Sacred Langur, mixed-species association, southwestern India.

ಎರಡು ಭಿನ್ನ ಪ್ರಭೇದ ಜೀವಿಗಳ ನೈಸರ್ಗಿಕ ಕಲೆಯು ವಿಶೇಷವಾಗಿ ವಿಸ್ತಾರವಾಗಿರುವ ಜೀವಿ ವರ್ಗೀಕರಣ ಶಾಸ್ತ್ರಜ್ಞರಿಗೆ ಹಾಗೂ ಪ್ರಾಣಿ ಶಾಸ್ತ್ರಜ್ಞರಿಗೆ ಕುತೂಹಲಕಾರಿ ವಿದ್ಯಮಾನವಾಗಿದೆ. ದಕ್ಷಿಣ ಭಾರತದ ಘಟ್ಟ ಪ್ರದೇಶಗಳಲ್ಲಿ ಇದುವರೆಗೂ ಎರಡು ಭಿನ್ನ ಪ್ರಭೇದ ಮುಳ್ಳುಗಳ ಬೆರೆಯುವಿಕೆಯನ್ನು ಕೇವಲ ಮೂರು ಪ್ರದೇಶಗಳಲ್ಲಿ ಮಾತ್ರ ದಾಖಲಿಸಲಾಗಿದೆ. ಪ್ರಸ್ತುತ ಲೇಖನವು, ತಮಿಳು ನಾಡಿನ ನೀಲಗಿರಿ ಸಂರಕ್ಷಿತ ಕ್ಷೇತ್ರದ ದೇವಿಮಲೆ ಫಾಲ್ಸ್ ನ (ಗುಡಲೂರು-ಉಪಿ ಮಾರ್ಗ) ಓ ವ್ಯಾಲಿ ಟೀ ಎಸ್ಟೇಟ್ ಸುತ್ತ ಮುತ್ತಲಿನ ಜಾಗದಲ್ಲಿ, ಅವಕಾಶಾವಶಾತ್, ಹದಿಮೂರು ಕೆರಿ ಮುಳ್ಳುಗಳ ಒಂದು ಗುಂಪನ್ನೂ, ಅದರಲ್ಲಿ ಕಂದು ಬಣ್ಣದ ಒಂದು ಬಿಳಿ ಹೆಣ್ಣು ಮುಳ್ಳು ಹಾಗೂ ಮೂನಾಕು ಕೆರಿ-ಬಿಳಿ ಮಿಶ್ರಿತ ಎಳೆಯ ಮುಳ್ಳುಗಳ ವಿವರಣೆಯ ಕುರಿತಿದ್ದಾಗಿದೆ. ಲೇಖನವು, ಭಿನ್ನ ಪ್ರಭೇದ ಜೀವಿಗಳ ಬೆರೆಯುವಿಕೆಯ ಕಾರಣಗಳನ್ನು, ಕೆರಿ ಮುಳ್ಳುಗಳ ಸಂತತಿಯ ಸಂದರ್ಭದಲ್ಲಿ ಆಗುತ್ತಿರುವ ಹಾಗೂ ಅವುಗಳ ಅತೀ ಸೂಕ್ಷ್ಮ ನೆಲೆಗಳು ಮನುಷ್ಯ ಕಾರಣಗಳಿಂದ ಮಾರ್ಪಡಿದ ಆಗುತ್ತಿರುವ ಕಾರಣಗಳಿಗಾಗಿ (ಜೀವಿಗಳ ವಾಸ ಸ್ಥಳಗಳಲ್ಲಿನ ಮಾರ್ಪಾಡುಗಳು ಇಂತಹ ಬೆರೆಯುವಿಕೆಗೆ ಅವಕಾಶ ನೀಡುವಂತಹ ಎಂಬುದರ ಬಗ್ಗೆ) ಗಮನ ಸೆಳೆಯುತ್ತದೆ. ಈ ಅಧ್ಯಯನವು, ದಕ್ಷಿಣ ಪಶ್ಚಿಮ ಘಟ್ಟಗಳಲ್ಲಿ ಕೆರಿ-ಬಿಳಿ ಮುಳ್ಳುಗಳ ಬೆರೆಯುವಿಕೆಯ ಸ್ಥಳಗಳು ಇನ್ನೂ ಹಲವಾರು ಪ್ರದೇಶಗಳಲ್ಲಿ ಇರಬಹುದು ಎಂದೂ ತೋರಿಸಿಕೊಡುವುದರ ಜೊತೆಗೆ ಇಂತಹ ಇನ್ನೂ ವಿಸ್ತಾರವಾದ ಅಧ್ಯಯನಗಳ ಅನಿವಾರ್ಯತೆಯನ್ನು ಪ್ರತಿಪಾದಿಸುತ್ತದೆ.

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INTRODUCTION

Interspecific short-term associations among animal groups are known to naturally occur in the context of competition for food (Dickman 1992), mutual benefit (Oates & Whitesides 1990), and hybridization (Anderson 1948; Arnold 1997; Alberts & Altmann 2001; Arnold & Meyer 2006). Such associations have generated varied interests among ecologists, behavioral biologists, and geneticists (Evans et al. 2001; Hewitt 2001; Keller et al. 2010; Cortes et al. 2019); however, when two different species live together as a single cohesive unit, interspecific associations are difficult to explain. These associations are difficult to understand when they are seen amongst the species which have well defined social organizations like primates. In other words, biologists are aware of the purpose of the casual encounters of two different species, however, there seems to be a dearth of information in biological literature in the case of two species that exist as a single group going beyond the casual encounters.

Mixed species associations (hereafter referred to as MSAs or interspecific associations) have been usually observed in animals that live in social groups such as birds, ungulates, primates, and cetaceans (Terborgh 1990; Grubb 1999; Krause & Ruxton 2002; Stensland et al. 2003). There have also been a few interesting studies of associations between species from different taxonomic orders (Rodman 1973; Hayashi, 1975; MacKinnon & MacKinnon 1978; Waterman & Roth 2007; Hugaasen & Peres 2008; Grueter et al. 2010). There is a debate that is available on the formation of mixed troops in primates in general and colobines in particular (Phillips-Conroy & Jolly 1986; Gautier 1988; Yeager & Kirkpatrick 1998; Cords 1990; Burton & Chan 1996; Heymann & Buchanann-Smith 2000; Mitani et al. 2000; Stensland et al. 2003; Rehg 2006; Reyer 2008; Werner et al. 2008). Terms like polyspecific associations and mixed-species associations have been applied synonymously to similar phenomena. While some studies have defined polyspecific associations in the context where two or more different species intermix without any physical interactions per se, others define MSAs as species interspersed literally (though for a little time) behaving like members of a single group foraging, grooming with occasional mating as well (Burton & Chan 1996). Such associations are known to vary in duration, frequency, range, and ecological and behavioral relations largely depending on the type of groups/species interacting (Cords 1990; Burton & Chan 1996; Porter 2001; Rehg 2006).

The majority of the available literature related to mixed associations in primates are derived from African primates (Klein & Klein 1973; Struhsaker 1981; Gautier-Hion et al. 1983; Waser 1984; Cords 1990; Oates & Whitesides 1990; Chapman & Chapman 2000; Stensland et al. 2003; Eckardt & Zuberbühler 2004). The reasons for such associations in African primates have been explained and well documented (Schaik & Hörstermann 1994; Freeland 1977; Stensland et al. 2003; Fam & Nijman 2011; Cortes et al. 2019), however, not much literature is available on mixed associations among Asian primates with respect to behavioral, ecological, and evolutionary topics illustrating the range of factors, processes, and mechanisms that affect associations and make similar inferences apart from a few studies (Tables 1, 2).

Taken together, these reviews suggest that MSAs amongst Asian primates seem to be fewer in comparison to African primates. Available data do not indicate whether fewer observations of such MSAs are due to sampling bias or due to lesser proportional existence in Asian colobines. The data available on a few instances of the MSA amongst Asian colobines are predominantly from southern Asia (Table 1). The associations in case of Tufted Grey Langurs and Nilgiri Langurs, colobines of southern India have only been documented in the past by a few studies around the Palghat gap (Chellam 1985; Hohmann 1988, 1991; Ramachandran & Joseph 2001) in the Western Ghats. Until now, associations between these colobines of southern India have only been recorded in Silent Valley, Top Slip, and Kalakkad-Mundanthurai areas in the Western Ghats. Despite these pieces of evidence, the available literature does not show any systematic analysis of MSAs among the colobines of the entire southern Asian region.

Tufted Grey Langurs and Nilgiri Langurs of southern India are well known distinct species, easily distinguishable by pelage color and vocalizations (Brandon-Jones 2004; Hohmann 1988, 1991). The Hanuman Langur also called Grey or Common Langur species are dispersed throughout most of India and Sri Lanka (Ellerman & Morrison-Scott 1966; Oates et al. 1994), and are also found in parts of Pakistan, Nepal (Roonwal 1984; Oates et al. 1994), Bhutan, and Bangladesh (Choudhury 2007). They are known to occur in a wide range of habitats from arid regions on the edge of the desert in Rajasthan to the rainforests of the Western Ghats and at altitudes from sea level (Nag et al. 2011) to 4,270m above mean sea level in the Himalaya (Hrdy 1977; Bishop 1978). The Tufted Grey Langur or Coromandel Sacred Langur or Madras Grey

Table 1. Reported interactions of Asian primates from the literature.

Species	Explanation	Remarks	References
Purple faced Langur-Hanuman Langur	Foraging	*	Hladik (1977)
Lion-tailed Macaque-Bonnet Macaque-Hanuman Langurs	Foraging	*	Singh et al. (2010)
Lion-tailed Macaque-Bonnet Macaque-Nilgiri Langurs	Foraging	*	Sushma & Singh (2006)
Lion-tailed Macaque-Hanuman Langurs	Foraging	*	Singh et al. (2010)
Hanuman Langur-Rhesus Macaque	Antipredatory	*	Mathur & Lobo (1989)
Rhesus Macaque-Crab-eating Macaque-Tibetan Macaque	Foraging	*	Burton & Chan (1996)
Rhesus Macaque-Crab-eating Macaque-Japanese Macaque	Foraging	*	Southwick & Southwick (1983)
Tonkean Macaque-Booted Macaque	Habitat	*	Riley et al. (2007)
Kloss's Gibbon-Mentawai islands Langur	Foraging	*	Tilson & Tenaza (1982)
Kra Macaque-Silvered Leaf Monkey- Javan Grizzled Langur-Proboscis Monkey	Foraging	*	Kurland (1973)
Rhesus Macaque-Pig-tailed Macaque		Hybrid	Malaivijitnond et al. (2007)
Crab-eating Macaque-Pig-tailed Macaque		Hybrid	Bernstein (1967)
Tonkean Macaque-Heck's Macaque		*	Watanabe et al.(1991); Bynum (2002)
Moor Macaque-Tonkean Macaque		Hybrid	Supriatna et al. (1992); Evans et al. (2001)
Sulawesi Crested Macaque-Heck's Macaque		*	Watanabe & Matsumura (1991)
Gorontalo Macaque-Heck's Macaque		*	Watanabe & Matsumura (1991)
Rhesus Macaque-Bonnet Macaque			Fooden (2000); Fooden et al. (1981); Koyama & Shekar (1981); Kumar et al. (2011)
Rhesus Macaque-Crab-eating Macaque		Hybrid	Stevison & Kohn (2009)
Japanese Macaque-Taiwanese Macaque		Hybrid	Kawamoto (2005)

* Lack of empirical evidence to explain the reasons for association

Table 2. Documented hybridizations between Asian colobines (wild and captive).

Hybridising Taxa	Location	Coordinates	Notes	References
<i>S. priam</i> X <i>S. johnii</i>	Indira Gandhi Wildlife Sanctuary, Anamalai, Tamil Nadu, India	76.846E & 10.469N	Natural hybrid	Hohmann (1988, 1991)
<i>S. johnii</i> X <i>S.p. thersites</i>	Kalakkad-Mundanthurai Tiger Reserve, Tamil Nadu, India	77.311E & 8.689N	Mating photograph	Chellam (1985)
<i>T. obscurus</i> X <i>S.p. thersites</i>	Sri Lanka	NA	Captive hybrid	Hill (1939)
<i>S. p. thersites</i> X <i>S.v. nestor</i>	Sri Lanka	NA	Captive hybrid	Hill (1936)
<i>S. p. thersites</i> X <i>S.v. nestor</i>	Sri Lanka	NA	Captive hybrid	Hill (1936)
<i>S. priam</i> X <i>S. johnii</i>	Madura Coats, Ooty, Tamil Nadu, India	NA	Hybrid photograph by Sally Walker	Brandon-Jones (2004)
<i>Pygathrix nemeaus</i> X <i>T. laotum hatinhensis</i>	Vietnam	NA	Hybrid captive	Schempp et al. (2008)
<i>T. pileatus</i> X <i>T. geei</i>	Bhutan	90.690E & 27.143N	Natural hybrid	Choudhury (2008)

S—*Semnopithecus* | T—*Trachypithecus* | v—*vetulus* | p—*priam*.

Langur *Semnopithecus priam* groups are organized into uni-male (only one adult male with more of other age and sex classes), multi-male, and all-male groups.

On the other hand, Nilgiri Langur or the Black Leaf Monkey *Semnopithecus johnii* is endemic to the rainforests of the Western Ghats of Tamil Nadu, Kerala, and to the hills of Coorg in Karnataka (Ryley &

Shortridge 1913; Tanaka 1965; Sunderraj 2001; Kumara & Singh 2004). The Nilgiri Langurs are usually found in tropical evergreen forests at elevations over 500m, however, in the habitats of the Kalakkad-Mundanthurai Tiger Reserve (KMTR) in the Tirunelveli Hills of Tamil Nadu, they are found even at an elevation of 180–200 m (Hohmann 1989; Sunderraj 2001). Nilgiri Langur groups

are organized into one or uni-male, multi-male, all-male, and all-female groups, however, multi-male and all-female groups are rare in Nilgiri Langurs (Tanaka 1965; Poirier 1968a; Sunderraj 2001).

In this paper, I briefly describe an opportunistic observation on Nilgiri-Grey Tufted langur associations in the Nilgiri Biosphere Reserve of southwestern India and add some relevant questions to the ongoing debate on interspecific interactions.

STUDY AREA

The study was opportunistically conducted at Nilgiri Biosphere Reserve in the southern Western Ghats of southern India. The first locality was at Neelikkal range, Silent Valley National Park, Kerala and the second locality was around O Valley tea estate, Devimalai Ghats (11.482N & 76.512E), a hilly terrain between Gudalur-Naduvattam-Ooty road interspersed with other tea estates at an elevation of 1,365m with an average rainfall of 3,000mm per annum.

Survey

Opportunistic surveys were conducted at the Silent Valley National Park, Kerala (December 2010), and

around Devimalai Ghats (December 2019) for Hanuman Langur and Nilgiri Langur association. The attempts were primarily focused to identify MSAs or hybrid members (only on morphotypic features) in the troops. The survey was primarily conducted in the southwestern part of the park, particularly in the Neelikkal area for a week based on earlier reports (Ramachandran & Joseph 2001) at Silent Valley, and twice around O Valley Devimalai Ghat road based on anecdotal reports and observations. During each visit, an attempt was made to maintain the slow pace in walking (approximately 1km/h) with frequent pauses to look and listen for langurs. Upon encountering monkeys, the data was recorded in terms of the time of the sighting, number of individuals, phenotypes of individuals, and the time the interaction lasted. Generally, the time of sampling was at 06.00–12.00 h and 15.00–18.00 h. Upon detecting troops, they were actively followed, maintaining contact as long as possible. For each of the encounters, the date and time of group detection was recorded along with the total time taken for observation period, number of individuals, phenotypes of individuals, and age-sex class of individuals whenever possible. If the interactions had more than two or more monkeys of two species engaging in affiliation such as foraging or, traveling along the same route of progression, or within 50–100 m of one

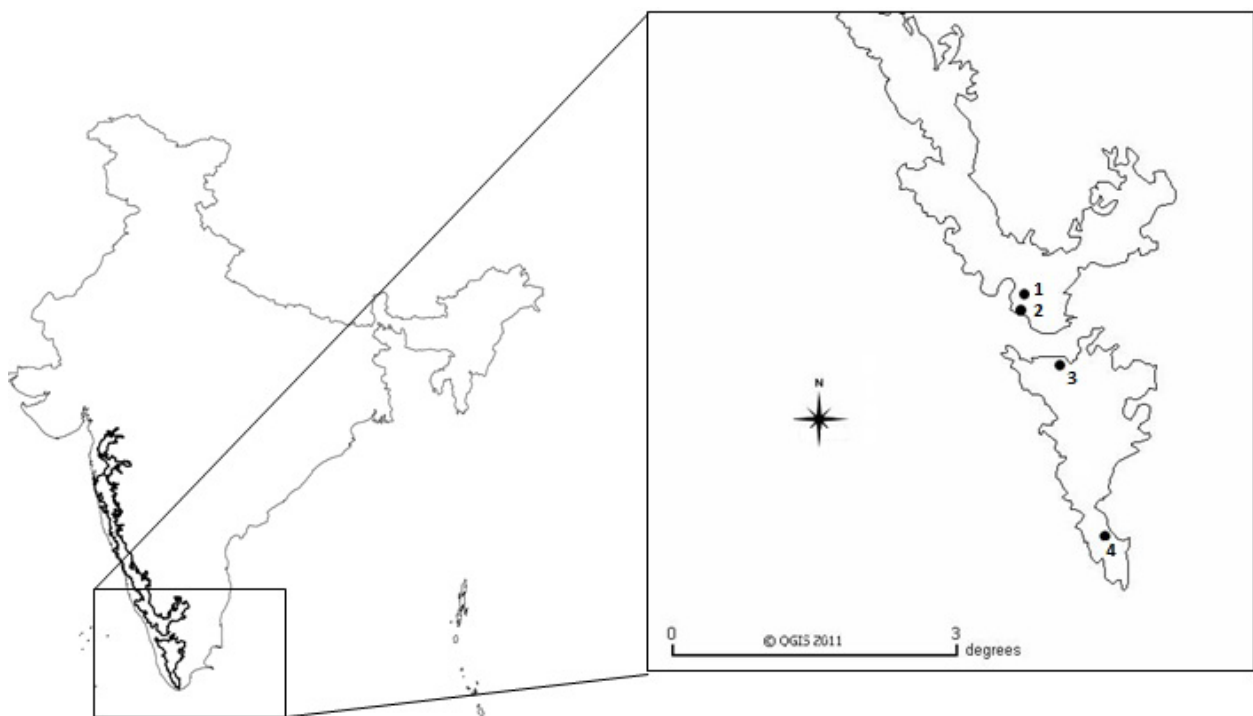


Figure 1. Study area denoting mixed-species associations of Hanuman langurs and Nilgiri Langurs in the Western Ghats of southern India reported from the literature. Numbers 1, 2, 3 & 4 denote Devimalai Ghat, Silent Valley National Park, Indira Gandhi Wildlife Sanctuary, and Kalakkad-Mundanthurai Tiger Reserve, respectively.

another, the study scored them as a group (Glenn 1997). Observations were made using an 8 X 40 Porro prism binoculars. Researchers, field assistants, forest staff, and local people were consulted for information on sightings of MSAs/ hybrids at the sites. A thorough review of the available literature and the recent reports on langurs of this area and MSAs was carried out. Methods described elsewhere (Hrdy 1977) were followed for defining the age-sex compositions in the Tufted Grey Langur troop.

RESULTS

Silent Valley National Park

In total, six and two uni-male troops of Nilgiri Langurs and Tufted Grey Langurs, respectively were observed in the Neelikkal section of Silent Valley National Park. Nilgiri Langurs were recorded between 800–1,121 m and Tufted Grey Langurs at around 913m. A total of 14km in search of Nilgiri Langurs and Tufted Grey Langurs was traveled. Nilgiri Langurs and Hanuman Langurs were observed to co-occur only at the edge of the evergreen forest habitat. Three Nilgiri Langurs were observed foraging with a Tufted Grey Langur troop at a

distance of about 50–75 m at Neelikkal for the whole of the study period, however, sexing and photographing these foraging Nilgiri Langur individuals was not possible due to limitations of visibility in the canopy. The nearest troops of Nilgiri Langurs were located >3km away from this Tufted Grey Langur troop. No aggression by the adults of Tufted Grey Langur towards Nilgiri Langurs was observed. During the period of observation, Nilgiri Langurs and Tufted Grey Langurs were either seen moving or feeding together. The same troop also had an adult Tufted Grey Langur female with aberrant coat color. This female, which was carrying a suckling infant at the time of observation, had brownish-black coat color giving an impression of a possible hybrid individual. In addition, I sighted a troop of Nilgiri Langurs close to the Kerala Forest Department camp shed in which an infant with Tufted Grey Langur coat color carried by a Nilgiri Langur adult female was observed twice on 16 December 2010 at 07.30h and 16.00h, respectively. Attempts to photograph them went in vain due to the tree cover and shyness of the Nilgiri Langurs to human proximity. Furthermore, local forest guards and watchers reported another troop of Nilgiri Langurs in and around the camp shed area in which three infants/juveniles with Tufted

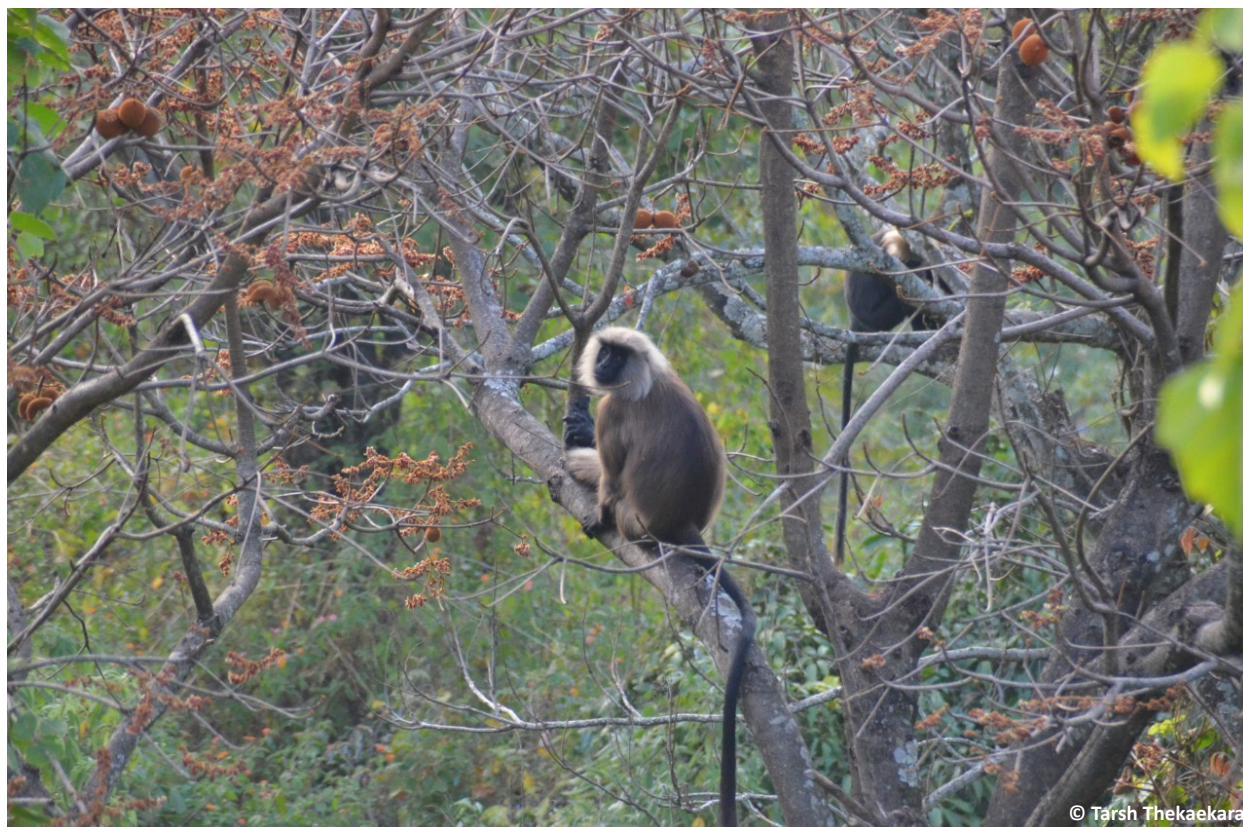


Image 1. A brownish adult female langur foraging with adult female Nilgiri Langur at Devimalai Ghats (Gudalur-Ooty road).



Image 2. Nilgiri Langur troop at Devimalai Ghats (Gudalur-Ooty road) with a brownish (hybrid?) juvenile.

Grey Langur coat color had been observed which could not be confirmed during my study period.

O Valley Tea Estate, Gudalur-Naduvattam Road

A troop of 11–13 individuals of Nilgiri Langurs with brownish individuals was observed near O Valley, Tamil Nadu (11.482N & 76.512E; 1,350m) on 28 December



Image 3. A brownish (hybrid?) juvenile at Devimalai Ghats (Gudalur-Ooty road).

2019 around 17.00h. I did not encounter adjacent Nilgiri-Tufted Grey Langur troops. The study troop at the time of observation had one adult male, four juveniles, two infants, one sub-adult, four adult females, and one brownish adult female. An adult brownish Tufted Grey Langur female (Image 1) was observed at about 5m foraging with Nilgiri Langur troop. During the period of observation, Nilgiri Langurs and female brownish Tufted Grey Langur were seen moving and feeding together. This troop also had two juveniles with brownish-black coat color (Images 2, 3) giving an impression of a possible hybrid individual. No aggression by the adults of Nilgiri Langur troop towards hybrid looking individual/s was observed. Tarsh Thekaekara (a post-doctoral research associate and tea garden owner where Nilgiri Langurs reside) has personally observed females of this Nilgiri Langur troop mating with a Tufted Grey Langur male from a nearby estate named Silver Springs. This male Tufted Grey Langur has never been observed around this Nilgiri Langur's troop, however, Nilgiri Langur females of this troop often have been observed to initiate the mating with Silver Spring Estate Tufted Grey Langur male (Tarsh Thekaekara pers. comm. March 2020).

DISCUSSION

Till date, there were only three confirmed localities (Silent Valley National Park, Top Slip in the Anamalais, and

Kalakkad-Mundanthurai Tiger Reserve) in the southern Western Ghats where associations of Nilgiri and Tufted Grey langurs have been reported. This study provides the fourth location of MSAs in the Nilgiri Hills. Anecdotal observations suggest that the focal troop is a residential one and thus associations and observations could not merely be a chance event, however, the association between Nilgiri and Tufted Grey langurs appears to involve not only hybrids, but langurs who could be coping in a human-disturbed habitat. The effects of such associations due to habitat fragmentation could as well be a possibility to explore and understand these short-term associations at such localities. The formations of interspecific associations are a complex phenomenon to explain. A variety of ecological explanations have been offered. But after a careful examination of interspecific associations in colobines of southern Asia, the available data shows that such mixed associations are formed between closely related species pairs which are recently diverged terminals of a phylogenetic tree. Given the available evidence of higher degree phylogenetic conservatism across the primate phylogenies with respect to the social behavior, it is reasonable to at least propose an ad hoc hypothesis which warrants rigorous analysis. The hypothesis argues that the MSA in colobines of southern Asia happens between a pair of recently diverged taxa that could be due to phylogenetic conservatism (Rendall & De Fiore 1995; Prinzing et al. 2001) in their social behavior. If this hypothesis is true, it would provide a robust framework to reanalyze the MSA in colobines.

Recent molecular phylogenetic analysis of langurs in Asia reveals that Hanuman Langurs are closely related to Nilgiri *Semnopithecus johnii* and Purple-faced langurs *S. vetulus* (Zhang & Ryder 1998; Karanth et al. 2008, 2010; Osterholz et al. 2008), which are distributed in peninsular India and Sri Lanka, respectively. Evidences from molecular data are supported by both ecological and behavioral data wherein Nilgiri Langurs and Hanuman Langurs are similar with respect to size of the troop, troop composition and ranging behavior (Tanaka 1965; Poirier 1968a; Hohmann 1989) and in some behavioral aspects like infant transfer, role of protection of the infants by males, and least protective behaviors of mothers (Tanaka 1965; Poirier 1968b). A review of the literature on such interactions between other similar sister species of Indian colobines revealed that there can exist a close interaction amongst these sister species (Table 1). Both these species are recently diverged taxa and form a close-knit monophyletic clade in a phylogenetic tree. Interestingly, a study by

Kavana et al. (2015) while determining the impacts of folivory on social time between Black-footed Grey Langur *Semnopithecus hypoleucos* and Nilgiri Langur in the Western Ghats concluded that phylogenetic inertia was not a constraint determining social behaviour of *S. hypoleucos* and *S. johnii* and that physiological constraint arising from varying degrees of folivory actually appeared to be the important factor. Thus, their study inferred that some traits such as degree of folivory and social time are phylogenetically conserved among Hanuman Langur species and hence, the current study reasonably speculates that the mixed species interactions and associations between Tufted Grey Langurs and Nilgiri Langurs of southern Western Ghats of southern India could be occurring on account of phylogenetic conservatism.

CONCLUSIONS

Taking into consideration the known distribution of Nilgiri Langurs and Hanuman Langurs in southern Western Ghats, it is reasonable to speculate that there could be more such MSAs wherever these two species are co-distributed in this range and elsewhere in the Western Ghats. In this regard, it is imperative to survey MSAs in the entire range of the Western Ghats where both Hanuman Langurs and Nilgiri Langurs co-occur possibly yielding more insights on the biology of these two species groups.

Given the fact that Gudalur-Naduvettam-Ooty road has high human influence and disturbances, the study appeals for more rigorous and systematic surveys on interspecific associations all along the distribution of Nilgiri Langur-Tufted Grey Langur distribution ranges including the entire Nilgiri District. Future studies should determine the ecological or habitat constraints facing both (associated) primate groups. These surveys can aid biologists and park managers to understand the biology of associations and implement appropriate conservation measures. Insights on such associations may have implications for conservation especially if induced by human activities like the introduction of species in areas outside their natural range, decrease in population densities of closely related species due to hunting and habitat fragmentation. A detailed systematic study on ecology, behavior, and molecular aspects of these associations must be the primary goal for future studies.

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