Online ISSN: 2588-3526

Journal of Wildlife and Biodiversity

Volume 5 (1): 53-62 (2021) (http://www.wildlife-biodiversity.com/)

Research Article

Distribution and relative abundance of Indian Giant Flying Squirrel (*Petaurista philippensis)* in Gujarat, India

Singh Nisha* and Dharaiya Nishith

Wildlife and Conservation Biology Research Lab, Department of Life Sciences, Hemchandracharya North Gujarat University, Patan, Gujarat, India (384265)
*Email: nishanicky1210@gmail.com

Received: 8 July 2020 / Revised: 25 July 2020 / Accepted: 7 September 2020 / Published online: 21 October 2020. Ministry of Sciences, Research, and Technology, Arak University, Iran.

How to cite: Nisha S, Nishith D. (2021) Distribution and relative abundance of Indian Giant Flying Squirrel (*Petaurista philippensis)* in Gujarat, India. 5(1), 53-62. **https://doi.org/10.22120/jwb.2020.130618.1163**

Abstract

We assessed the distribution pattern and abundance of *Petaurista philippensis* in the state of Gujarat, India. It is the only species of flying squirrel found in the western states of India. The species was distributed on a large geographic area with confined populations in the eastern dry and moist deciduous forest stretch with tall trees within the state. During the study period, 33 times flying squirrels were encountered at 14 sites in 7 districts, concentrated mainly in protected areas. The overall encounter rate was 0.50 individuals/km among which, the central districts of Gujarat showed the highest while the north-east districts showed the lowest abundance of *P. philippensis*. It was found to be a tree-dwelling species, positively associated with old-growth forests with tall trees. The abundance rates were found to be associated with forest degradation and hunting practices. Illegal hunting practices persists in some areas of Gujarat, may affect the population number and trend. Apart from forest degradation and fragmentation, hunting for domestic consumption, ethnomedicinal uses, traditions, and human-made forest fires were the major potent threats of flying squirrels as found during the present study.

Keywords: Arboreal, encounter rate, protected areas, rodents, western India

Introduction

With about 2277 species in 481 genera under 33 families, Rodentia is the single largest group of mammals globally (Wilson & Reeder, 2005) with the broadest distribution throughout and occupies almost every habitat in any geographic area. Out of the 48 species (15 genera) of flying squirrels worldwide (Corbet & Hill, 1991, Thorington et al., 1996), India is known to have a diversity ranging between 9-12 species (Corbet & Hill, 1991, Thorington et al., 2012, Menon, 2014); mainly concentrated in the northeast and Himalayan regions. Indian Giant Flying Squirrel (IGFS) dominates all the species being widely distributed in the tropical and sub-tropical forests of south and Southeast Asia (Corbet & Hill, 1992, Nandini, 2000, Wilson & Reeder, 2005, Koli et

al., 2013). It is found up to 2050 m of elevation, with the highest encounter rates between 50–500 m elevations (Nandini, 2001, Koli et al., 2013).

Several studies on distribution, ecology, behavior, abundance, and population trends of flying squirrels species have been carried out in India (Umapathy & Kumar, 2000, Nandini, 2001, Kumara & Singh, 2004, 2006, Koli et al., 2013, Krishna et al., 2016, Nisha & Dharaiya, 2016), however most of the baseline information regarding flying squirrels has been obtained through the continuous studies conducted in Japan (Baba et al., 1982, Ando & Shiraishi, 1985, Kawamichi, 1997) and Taiwan (Lee et al., 1986, Lin & Lee, 1986, Lin et al., 1988, Lee et al., 1993).

Gujarat is the westernmost distribution range of *P. philippensis* in India. The presence of a good number of *Madhuca indica* trees with minimum human presence makes a typical habitat for this squirrel in Gujarat (Singh, 2013). Anonymous (1961) found flying squirrels to be restricted to well-wooded heavy forests of Dangs (Wroughton, 1911), Vansada National Park, Ratanmahals Sanctuary, Sabarkantha, Dahod, Vadodara, and Kewadi forests. Recently, it was reported from *M. indica* groves in Polo forest (north-east Gujarat) and Jambughoda Wildlife Sanctuary (central Gujarat) (Singh et al., 2016). The state's recent field survey indicates new locations with flying squirrel presence other than the old known locations (Nisha & Dharaiya, 2016). The present study highlights the current distributional range and abundance of IGFS in Gujarat state as baseline data for future planning and site-specific conservation action plan for the species and proper management of their associated habitat.

Material and methods

Our study covers the entire state of Gujarat located in the western part of India (20° 07' to 24° 43' N and 68° 10' to 74° 29' E). It is a distinct geographic zone with boundaries marked with the Arabian Sea and ranges like Aravallis, Vindhyas, and Satpura. The state has a total forest cover of 18,927 km^2 i.e., approximately 9.66% of its geographical area (Vaghela, 2013). Twenty-two wildlife sanctuaries, 4 National Parks, and two biosphere reserves (www.forests.gujarat.gov.in) have been established in different biogeographic and geomorphological zones in Gujarat. The state has varied forest types ranging from the deciduous and teak forest in the central part, moist deciduous forest in the south, thorn forests and grasslands in Kachchh, and scrub forests at several places in north Gujarat. Gujarat's Eastern border has a discontinuous chain of hilly forest areas that forms part of the Aravallis, Vindhyas, Satpura, and Sahyadri ranges. The Tropic of Cancer passes through Gujarat, giving it a sub-tropical climate that can be broadly classified in three distinct seasons viz. monsoon (June-September), winter (November-February), and summer (April-May). Temperature varies from 4 °C to 46 °C with an annual rainfall of 400 to 2000mm (Pandey et al., 2004).

A reconnaissance study was conducted in the state's significant forests except for the western districts of Gujarat, as no historical records of flying squirrels were found from the western parts of the state. Therefore, the eastern forested belt with protected areas was narrowed down and considered for intensive study (Fig. 1). The research includes only the areas with previous records of IGFS, leaving the areas where no earlier records of the species were obtained either through a literature survey or any other source of information.

One National Park (NP), six Wildlife Sanctuaries (WLS), and two patches of unclassed forests of 10 districts of Gujarat falls under our study area (Fig. 1). These protected and non-protected areas vary in size ranging from 10.84 km^2 of Purna WLS in The Dangs to 607.7 km^2 of Shoolpaneshwar WLS in Narmada district. Major forest types varied from Dry mixed deciduous,

tropical thorn forests to Moist mixed deciduous forest **(**Champion & Seth, 1968). The major flora includes *Terminalia tomentosa, T. arjuna, T. bellerica, T. grandis, T. crenulata, Tectona grandis, Buchanania lanzan, Ficus hispida, Lannea coromandelica, Anogeissus latifolia, D. melanoxylon, M. longifolia, L. parviflora, M. parviflora, L. coromandelica, and syzygium cumini.*

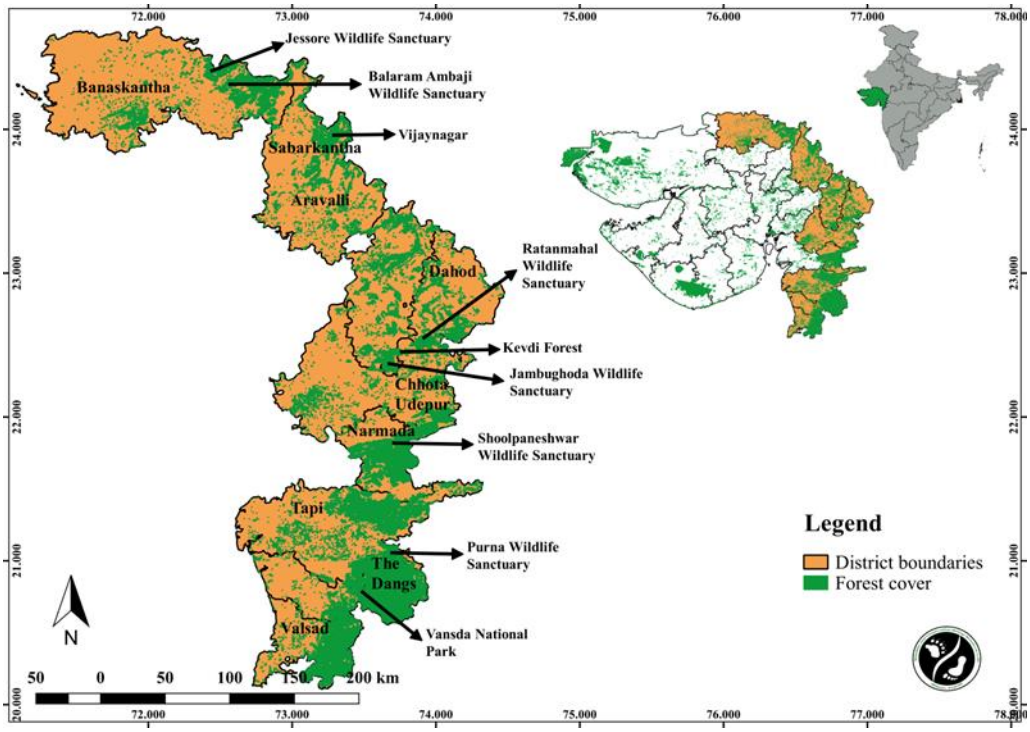

Figure 1. Map showing the locations of protected areas selected for intensive study within the eastern forest strip of Gujarat State

Questionnaire survey

Interviews with local people and a field survey to locate IGFS in the study areas were performed during the study period. A survey before the fieldwork was developed through SurveyMonkey® (www.surveymonkey.com; Nisha & Dharaiya, 2016) to collect information about the distribution and ecology of IGFS in Gujarat from people.

During our field survey, local people were shown a collage of different small mammals, including the IGFS, and asked the local names and checked if they identify and know about the IGFS. Respondents were generally the local stakeholders (labors, farmers, and forest dwellers), and tribal and their feedback was recorded. Local personal and tribes were very helpful in defining flying squirrels in respective areas and locating their potential habitats. A survey through a semi-structured questionnaire was also conducted among the local people and forest staff from the study area to know about their knowledge on IGFS distribution in their localities, general ecology such as feeding, breeding, nesting locations, major threats, and practice of hunting.

Status and distribution through Sign surveys

Some mammal species are challenging to observe and count because of their highly secretive nocturnal habit and/or low-density occurrence (Babu & Jayson, 2009). Identifying and interpreting the pieces of evidence left by mammals such as pellets, tracks, burrows, or feeding signs not only offer information about their habits (Wemmer et al., 1996) but also are time effective and thus can be used for presence survey to cover large areas (Macdonald et al., 1998).

Surveys were conducted on existing trails for presence/absence data without any preference for present only areas using sign survey with frontline field staff. Interactions with locals were made,

and the location of species and nesting sites were searched and identified. The presence of IGFS were recorded based on both direct shreds of evidence (sightings and calls), and indirect evidences (pellets, feeding remnants, defoliated tree branches, dried hanging twigs on trees or nests) (Koli et al., 2013, Singh & Dharaiya, 2018).

Finding IGFS

Being a nocturnal species, field surveys were carried out between 1800 to 2300 hrs and again from 0300 to 0600 hrs in the morning on forest trails using a spotlight to locate the flying squirrel. Binoculars were used for identification and observing its activities. During the night, the presence of flying squirrels can be easily detected in a given locality by reddish-brown color eyeshine (Koli & Bhatnagar, 2015) with a flashlight, listening to their faint squeaking calls, sounds of their movement, and gliding activities. Although squirrels concealed their presence by minimizing movements, they were typically detected by the sounds made from gnawed twigs or fruits, broken branches or peeled bark, felled remnant plant parts, or glides between tree canopies. Sites, where the signs or presence of flying squirrels was confirmed were geotagged using a Global Positioning System (GPS).

Species abundance

Night surveys were carried out on foot with taking all care for minimum disturbance or noise while searching trees for the presence of IGFS using flash light. Encounters of squirrel presence during survey were calculated based on direct sightings and calls in different forest types (following Kumar & Singh, 2006). IGFS encounter rate, or 'sightings' per km of trail walked is used as an index for estimating relative abundance in an area (Anonymous, 1981, Sutherland, 2002).

$$Encounter\ rate = \frac{n}{l} \quad (1)$$

Where, n=Number of individuals, l=Length of the trail

Results

Occurrence and distribution of *P. philippensis* in Gujarat

IGFS were found to be distributed in Moist deciduous and Dry deciduous forest types ranging from northern Gujarat, through northeast Gujarat up to south Gujarat bordering Maharashtra. The distribution of the species was found to be restricted in the North-East to central and Southern strip of forests in the state, across four WLS (Jambughoda WLS, Ratanmahal WLS, Shoolpaneshwar WLS, Purna WLS), one NP (Vansda NP), and one reserved forest (Polo) in seven districts (Fig. 2). Hence, we infer that the distribution of the *P. philippensis* is restricted to eastern Gujarat only. The species' distribution was further found to be patchy, suggesting the limited utilization of niches and resources by the species during its lifetime.

Approximately 1000 presence signs were collected from Gujarat through a sign survey. However, flying squirrels were encountered only 33 times at 14 sites, predominantly located in the protected areas. Fifteen sites were in the protected areas, while 18 sites were present outside or at the periphery of protected areas. The highest number of IGFS sightings were recorded in central Gujarat, having two WLS and few patches of non-protected forests, followed by the southern part of Gujarat and least in north Gujarat (Fig. 2). The elevation of these sites ranged from 257 to 351m.

The relative abundance of IGFS

The encounter rate is well associated with the population and distribution of a species in an area. We had a total of 38 flying squirrel sightings during the study period. The encounter rate varied

substantially (0.3-2.5 individuals/10 km) among different forest patches, with the highest encounter rate reported (0.32 individuals/km) in central Gujarat followed by south Gujarat (0.08 individuals/km) and then in north Gujarat (0.02 individuals/km) (Fig. 3). The overall encounter rate of *P. philippensis* in the state was 0.14 individuals/km. Often, individuals were observed solitary, exceptions to females with young ones or mating pairs. The sighting of a couple of IGFS was made during the study in April (breeding season) in central Gujarat.

The relative abundances were higher in dry and mixed deciduous forests than moist deciduous forests (Table 1). The most significant number of IGFS sightings occurred in dry and mixed deciduous forests (80.6 %), followed by moist deciduous forests (19.4 %).

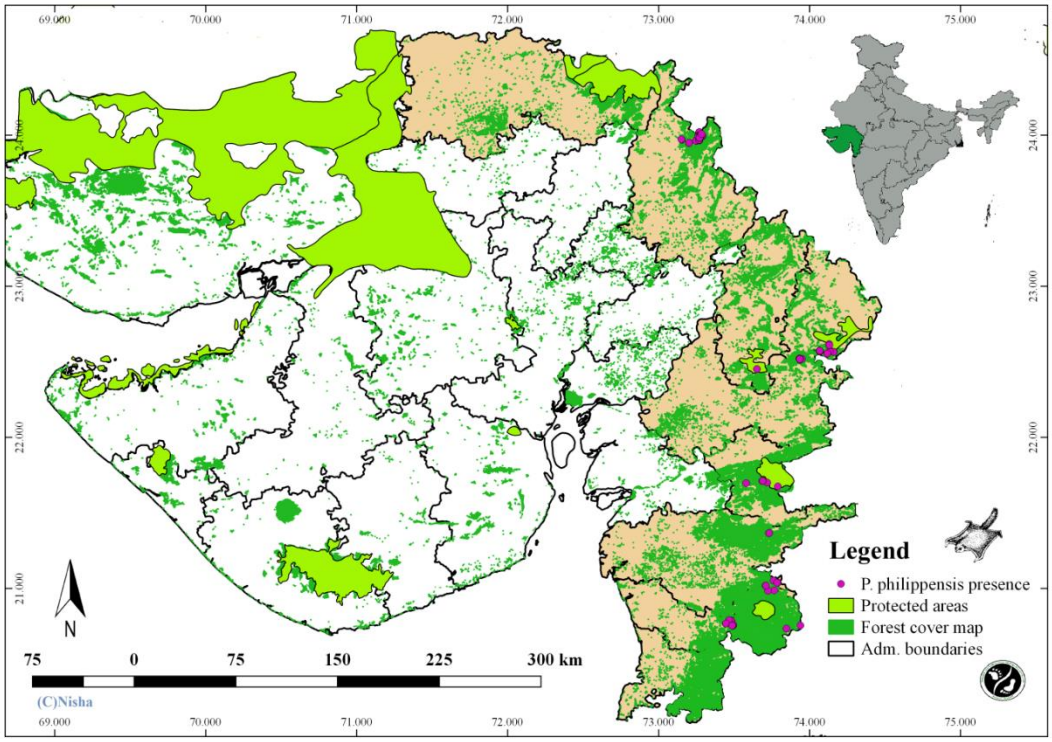

Figure 2. Distribution of *P. philippensis* in different protected, non-protected and reserved forests of Gujarat, India

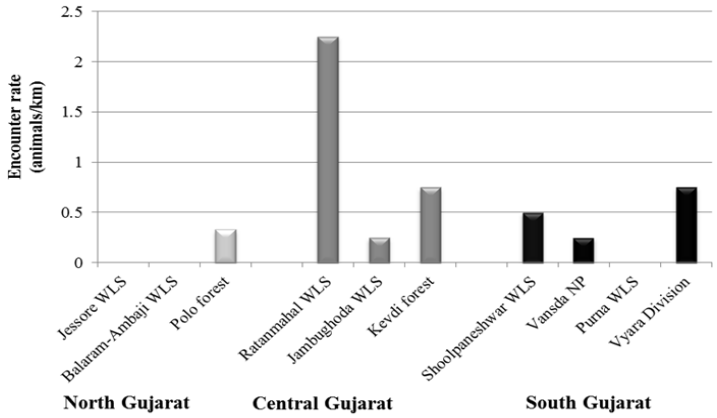

Figure 3. Encounter rates of *P. philippensis* in protected and non-protected areas of Gujarat

Discussion

Occurrence and distribution of *P. philippensis* in Gujarat

Forest patches in Gujarat's central part are covered with diverse tree species composition, including the feeding species for flying squirrels (Singh & Dharaiya, 2018). These forests are also dominated by the *M. indica,* which provide a perfect niche for the survival of IGFS. Although it is not the same scenario for other parts of state as areas of southern and northern Gujarat vary in vegetation structure completely, i.e., Northern forests are teak dominated along with other feeding species such as *T. tomentosa, T. bellerica, S. cumini* while Southern forests have dense and tall trees with *T. tomentosa* dominating the species along with others.

Table 1. Relative abundance (squirrels/km) of *P. philippensis* in different protected areas of Gujarat by spotlight count method

Region	Protected area	Total walking effort (km)	IGFS encountered	Encounter rate (individuals/km)
North Gujarat	Jessore WLS	6	0	0
	Balaram-Ambaji WLS	4	0	0
	Polo forest	6	2	0.33
Central Gujarat	Ratanmahal WLS	4	9	2.25
	Jambughoda WLS	4	1	0.25
	Kevdi forest	4	3	0.75
South Gujarat	Shoolpaneshwar WLS	4	2	0.5
	Vansda NP	4	1	0.25
	Purna WLS	4	0	0
	Vyara Division	4	3	0.75

M. indica provides nesting and feeding grounds for flying squirrels and is the most preferred tree for consumption by the species (Nisha, 2017, Singh & Dhariya, 2018). Koli et al. (2013) suggested the distribution of *M. indica* tree to be the possible factor in patronization of the flying squirrel population in the forests of southern Rajasthan. Similarly, Kumara & Singh (2006) found flying squirrels distribution restricted in the riverine forests with tall trees in Karnataka state. They further suggested hunting practices to be a reason for the patchy distribution of IGFS in the Eastern Ghats. Habitat extent, forest fragments, forest connectivity, vegetation, tree species, and elevation play an essential role in distributing arboreal species (Umapathy & Kumar, 2000).

The majority of IGFS sightings (76.19 %) occurred in Protected Areas, and only 23.81% of sightings occurred in Reserved Forests. Though in protected areas, too, they were found to be confined in small patches. IGFS are known to occupy a wide range of habitat (moist and dry deciduous forests), relatively small home ranges varying from 0.46 to 5.16 ha depending upon the distribution of food and nesting sites (Baba et al., 1982), and feeds on a variety of plant species and its part (Singh & Dharaiya, 2018). Thus, the distribution and availability of plant species could be considered the species' distribution driver. Being an arboreal species, open spaces created by forest cuts act as physical barriers for these species, leading to population isolation.

The relative abundance of IGFS

Abundance ranged from 0.25 to 2.25 individuals/km. There is a possibility of bias in this approach as the trails used for the survey are predefined. There is a possibility to cause a change in detectability of individuals along these trails due to disturbances being driven by open canopy cover. Trails may affect the distribution of species by modifying the habitat and resource availability. Vegetation alone is also not the only factor governing flying squirrel occupancy but they also have preferences for certain habitat attributes that need to be studied.

The species' encounter rate and population were highest in Ratanmahal WLS where the human interference was also found to be increased. The flying squirrels of Ratanmahal WLS are so adapted to humans' presence that they do not show any specific reflex response. During communication with locals, we also came to know about the hunting practices in the area. However, with time as the lifestyle changed due to modernization and awareness about wildlife policies, no hunting incident was recorded during the study. But it is believed by the local and forest staff that once a time, there were more than 50 flying squirrels in the area, which now had reduced around 30 in number (personal communication with locals in Ratanmahal WLS). *P. philippensis* was sighted rarely in South Gujarat forests, where they are hunted presently. Further, their presence was only found in the protected areas. In other places where hunting is not severe or has stopped completely, it was found comparatively in good numbers.

During the study, IGFS were also sighted close to human habitations feeding on fruits and tree parts but were never found to occupy nests in plantations. These results vary with previous study findings in south India (Umapathy & Kumar, 2000, Rajamani, 2001), where IGFS were reported from plantations, degraded and fragmented forests. This could be related to the variations in tree species composition and diversity between the study areas, availability of nest dwelling sites in plantation and protection, or lack of plantation culture in Gujarat.

Further, interspecific competition for forest fragments' resources also affects the relative abundance of species leading to resource portioning (Kozakiewicz, 1993). However, being the only species of flying squirrel found in the state, no such resource overlapping was observed for IGFS in Gujarat. Flying squirrels density in old-growth stands in Oregon and Washington was higher than in young stands (Carey et al., 1991). Due to the ability to climb tall trees and glide, deciduous forests form a more suitable habitat for *P. philippensis*, having relatively more open canopy.

Conclusion

Although IGFS was found to be confined in the eastern belt of Gujarat but is well populated in central Gujarat compared to other regions of the state, the absence of past distributional records of IGFS in the state did not allow us to compare the changes in its current distributional range. An abundance of feeding tree species providing food and nesting grounds for breeding seems to affect the distribution of IGFS in Gujarat's different forests. Lack of hunting practices along with suitable habitat has helped IGFS to grow in numbers in central Gujarat.

During the survey, it was felt that people were not much aware of the flying squirrel's presence and ecology because of its nocturnal and cryptic habits. These situations also stand as a challenge before the policymakers to educate the tribes, generate awareness and prepare species-specific management plans. Intensive increasing human population, interference, and encroachment in the forest areas are disturbing squirrel habitats. Looking at their low reproductive rate and abundance in this study, hunting, and habitat modification will play a significant role in deciding the future of this species in Gujarat.

Acknowledgment

We express our sincere thanks to the Principal Chief Conservator of Forest, Gujarat Forest Department, for providing the necessary permission and logistic support to carry out the research.

We thank every forest department staff for their constant support during field surveys in their respective areas.

References

Ando, M., Shiraishi, S., & Uchida, T. A. (1985). Feeding behaviour of three species of squirrels. Behaviour, 95 (1-2), 76-86. https://doi.org/10.1163/156853985X00055

Anonymous. (1981). Techniques for the study of primate population ecology. Washington, DC. National Academy Press.

Annonymous. (1961). Gujarat State Gazetteers: Broach District. Directorate of Government Printing, Stationery and Publications, Gujarat State.

Baba, M., Doi, T., & Ono, Y. (1982). Home range utilization and nocturnal activity of the Giant flying squirrel, *Petaurista leucoenys*. Japanese Journal of Ecology, 32, 189-198. https://doi.org/10.18960/seitai.32.2_189

Babu, S., & Jayson, E. A. (2009). Anti-predator behaviour of large brown flying squirrel (*Petaurista philippensis*): is this an effective census method to survey the species. Current Science, 96, 772-773.

Carey, A. B. (1991). The biology of arboreal rodents in Douglas-fir forests. U.S. Forest Service General Technical Report.

Champion, H. G., & Seth, S. K. (1986). Revised Survey of Forest Types of India. Government of India Press.

Corbet, G. B., & Hill, J. E. (1992). The mammals of the Indomalayan region: A systematic review (pp. 306-320). Oxford University Press.

Corbet G.B., Hill, J.E. 1991. A World List of Mammalian Species, Third edition. Natural History Museum Publications & Oxford University Press.

Kawamichi, T. (1997). Seasonal changes in the diet of Japanese Flying Squirrels in relation to reproduction. Journal of Mammology, 80, 589-599. https://doi.org/10.2307/1382653

Koli, V., & Bhatnagar, C. (2015). Distribution and ethology of *Petaurista philippensis* in Rajasthan. Thesis. Lambert academic publishing.

Koli, V. K., Bhatnagar, C., & Sharma, S. K. (2013). Distribution and status of Indian giant flying squirrel (*Petaurista philippensis* Elliot) in Rajasthan, India. National Academy Science Letters, 36, 27–33. https://doi.org/10.1007/s40009-012-0105-z

Kozakiewicz, M. (1993). Habitat isolation and ecological barriers - the effect on small mammal populations and communities. Acta Theriologica, 38(1), 1-30. https://doi.org/10.4098/AT.arch.93-1

Krishna, M. C., Kumar, A., Tripathi, O., & Koprowski, J. (2016). Diversity, Distribution and Status of Gliding Squirrels in Protected and Non-protected Areas of the Eastern Himalayas in India. Hystrix the Italian Journal of Mammalogy, 27(2), 111–119. https://doi.org/10.4404/hystrix-27.2-11688

Kumara, H. N., & Singh, M. (2006). Distribution and relative abundance of giant squirrel and flying squirrel in Karnataka, India. Mammalia, 70, 40-47. https://doi.org/10.1515/MAMM.2006.006

Kumara, H. N., & Singh, M. (2004). The influence of differing hunting practices on the relative abundance of mammals in two rainforest areas of the Western Ghats, India. Oryx, 38, 321-327. https://doi.org/10.1017/S0030605304000560

Lee, P. F., Progulske, D. R., & Lin, Y. S. (1986). Ecological studies on the two sympatric giant flying squirrel species (*Petaurista petaurista* and *P. alborufus*) in Taiwan. Bulletin of the Institute of Zoology, Academia Sinica, 25(1), 113-124.

Lee, P. F., Lin, Y. S., & Donald, D. P. (1993). Reproductive biology of the red-giant flying squirrel, *Petaurista petaurista* in Taiwan. Acta Zoologica Taiwanica, 3, 165-170. https://doi.org/10.2307/1382437

Lin, Y. S., Wang, L. L., & Lee, P. F. (1988). The behavior and activity pattern of Giant flying squirrels (*Petaurista p. grandis*). Quarterly Journal of Chinese Forestry, 21(3), 81-94.

Macdonald, D. W., Mace, G., & Rushton, S. P. (1998). Proposals for the Future Monitoring of British Mammals. DETR, London.

Menon V. 2014. A Field Guide to Indian Mammals. Hachette Book Publishing India.

Nandini, R. (2001). The status and distribution of the small Travancore flying squirrel (*Petinomys fuscocapillus fuscocapillus*) and the large brown flying squirrel (*Petaurista philippensis*) in the Western Ghats. Technical report. SACON.

Nisha. (2017). A study on status and distribution of Indian Giant Flying Squirrel (*Petaurista philippensis*) to identify its critical habitats in Gujarat and its conservation. PhD Thesis. Hemchandracharya North Gujarat University.

Rajamani, N. (2000). Ecology and behavior of the large brown flying squirrel *petaurista philippensis* in a rainforest fragment, Western Ghats. M.S. dissertation, Pondicherry University, Pondicherry.

Nisha, & Dharaiya, N. (2016). A virtual survey based debate on Conservation Strategies of Indian Giant Flying Squirrel (*Peatuarista p. philippensis*). Ambient Science, 03(1), 16-21. https://doi.org/10.21276/ambi.2016.03.1.ra02

Pandey, C. N., Patel, S. P., Chavan, S., Salvi, H., Patel, B. H., Vyas, R., Trivedi, P., Jethva, B., & Aiyadurai, A. (2004). The status of biodiversity in Purna Wildlife Sanctuary (a comprehensive ecological and socio-economic study). Gandhinagar, India: GEER Foundation.

Singh, H. S. (2013). Mammals in Gujarat. Gujarat Biodiversity Board, Gadhinagar and Gujarat Forest Department, Gandhinagar.

Singh, N., & Dharaiya, N. (2018). Feeding patterns of Indian Giant Flying Squirrel (*Petaurista philippensis*, Elliot 1839) with reference to seasonal variation in Central Gujarat, India. Journal of Forestry Research, 30, 1959–1965. https://doi.org/10.1007/s11676-018-0762-y

Singh, N., Dharaiya, N, & Vora, U. V. (2016). Report of Indian Giant Flying Squirrel (*Petaurista philippensis* Elliot, 1839) from Jambughoda Wildlife Sanctuary, Panchmahal district, Gujarat. Small Mammal Mail, 8(1), 24–26.

Sutherland, W. J. (2002). Mammals. In: Sutherland WJ, editor. Ecological censusing techniques (pp. 260–278). Cambridge University Press.

Thorington, R. W. Jr., Mus Ante, A. L., Anderson, C. G., & Darrow, K. (1996). The validity of three genera of flying squirrels: *Eoglaucomys*, *Glaucomys*, and *Hylopetes*. Journal Mammal, 77, 69–83. https://doi.org/10.2307/1382710

Thorington, R. W. Jr., Koprowski, J. L., Steele, M. A., & Whatton, J. F. (2012). Squirrels of the world. Johns Hopkins University Press.

Umapathy, G. U., & Kumar, A. (2000). The occurrence of arboreal mammals in the rain forest fragments in the Anamalai Hills, South India. Biology Conservation, 92, 311–319. https://doi.org/10.1016/S0006-3207(99) 00097-X

Vaghela, R. P. (2013). Glimpses of Forests in Gujarat, Forest Department, Gujarat State.

Wemmer, C., Kunz, T. H., Loudie-Jenkins, G., & McShea, W. J. (1996). Mammalian sign. In: Measuring and monitoring biological (pp. 157-176). Smithsonian Institution Press.

Wilson, D. E., & Reeder, A. E. (2005). Mammal species of the world: a taxonomic and geographic reference. 3rd ed. Johns Hopkins University Press.

Wroughton, R. C. (1911). Oriental flying squirrels of *Pteromys* group. Journal Bombay Natural History Society, 26, 338-379.