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Nesting trees of the Red Giant Gliding Squirrel *Petaurista petaurista* (Mammalia: Rodentia: Sciuridae) in a tropical forest of Namdapha National Park, India

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Abstract: The present study investigated the nesting habits of the Red Giant Gliding Squirrel in the tropical forest of Namdapha National Park, India within the time period of 2012–2013. Gliding squirrel nest trees were located by searching for them with using spotlighting during evenings and early mornings. For each den site we recorded data on nesting tree species, total height of tree, height of the nest on tree, tree diameter at breast height (DBH), and canopy connectivity of the nesting tree. We observed *P. petaurista* using cavity nests (n=27) in eight tree species. The majority of nest trees observed were in *Altingia excelsa* (40.7%) and *Terminalia myriocarpa* (22.2%). Trees with less canopy connectivity were preferred for nesting where 59.3% of nest trees had <25% canopy connectivity. *Petaurista petaurista* nested in trees with an average of 31.1±0.86m (Mean ± SE) height and the nests were located at a mean height of 17.8±0.89m (SE) (min & max: 9.3m & 35.2m). Mean DBH of nesting trees was 70.6±0.98cm (SE) (min & max: 38.2cm & 168.8cm). This data helps in filling the gaps on the denning ecology of the species and may be useful for the management and conservation purpose of forest trees.

Keywords: Arboreal nests, Arunachal Pradesh, giant gliding squirrels, canopy connectivity, northeastern India, secondary cavity nesters.

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Author contribution: MCK did all the field work and wrote the manuscript. AK helped in planning the study and was responsible for planning the course of manuscript. OPT helped in planning the survey for collecting and analyzing the data on vegetation.

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IDEA WILD

Government of India
Department of Science & Technology

INTRODUCTION

Understanding the ecology of a species is crucial for its conservation and management. Although mammals are among the most studied taxon groups, the ecology of nocturnal arboreal mammalian ecology remains understudied (Bonnet et al. 2002; Clark & May 2002; Jayasekara et al. 2007). Due to knowledge gaps, nocturnal arboreal mammals, such as gliding squirrels, are underrepresented in conservation action plans (see Koprowski & Nandini 2008; Datta & Nandini 2014).

Nesting ecology of gliding squirrels is an important aspect of their biology and is pertinent to their conservation and management. Gliding squirrels use nests for diurnal refuge, shelter from predators and adverse weather conditions, reproduction, and hoarding sites (Cowan 1936; Weigl & Osgood 1974; Weigl 1978; Lee et al. 1986; Bendel & Gates 1987; Shafique et al. 2009). Three types of nests are used by gliding squirrels — tree-cavities, external leaf nests and subterranean nests (Carey et al. 1997; Hackett & Pagel 2003; Holloway & Malcolm 2007). The availability of large, dying, and dead trees has been found to influence nesting strategies among gliding squirrels (Carey et al. 1997; Menzel et al. 2004). Subterranean nests are the least common ones that are observed under the tree roots, downed logs and under rocks (Gerrow 1996; Hackett & Pagels 2003; Diggins et al. 2015). In areas with high snag densities, cavity nests tend to be most prevalent, and in low snag areas with timber harvesting and low cavity availability high external nest use is observed (Carey et al. 1997). At times, drey's are even observed where the squirrels build nests in the tree branches (Hanski et al. 2000). Of the various nesting types discussed above, cavity-nesting has evolved as an adaptation to avoid predation (Martin 1998) and such nesting is considered important for gliding mammals like gliding squirrels (e.g., Taulman 1999; Holloway & Malcolm 2007) and gliding marsupials (e.g., Traill & Lill 1997; Lindenmayer 2002).

The objective of our study was to determine nesting tree characteristics of the Red Giant Gliding Squirrel in tropical forests of Namdapha National Park of Arunachal Pradesh, India (Image 1).

Image 1. Red Giant Gliding Squirrel in Namdapha National Park, Arunachal Pradesh.

MATERIAL AND METHODS

Study Site

The study was carried out at Namdapha National Park (NNP; 27.391–27.661 ^{0}N & 96.250–96.975 ^{0}E; area 1,985km²) which lies in the eastern Himalayan region of Arunachal Pradesh, India (Fig. 1). The park contains some of the northernmost tropical rainforests of the world (Proctor et al. 1998) and the temperature in the park varies along with altitude ranging between 4–35 ^{0}C at altitudes below 2,000m and at higher elevations, the temperature often drops below the freezing point in winters (Ray et al. 2015). Monthly precipitation ranges from a minimum of 1,400mm and maximum of 2,500mm, 75% of which falls between April and October (Kumar et al. 2009). Details on park vegetation are reported by Ghosh (1987), Nath et al. (2005), and Ray et al. (2015). Our study was carried out in Deban (27.483^{0}N; & 96.383^{0}E), Gibbons Land (27.500^{0}N & 96.316^{0}E) and Hornbill Camp (27.533^{0}N & 96.433^{0}E) (Murali et al. 2014) areas within the park and the elevation range of these three study sites range between 200m and 550m. The study sites are dominated by tall trees ranging from 15m to 45m including common species such as *Duabanga grandiflora*, *Neolamarckia cadamba*, *Biscofia javanica*, *Cinnamomum* sp., *Shorea assamica*, *Castanopsis* sp., *Ficus* sp., *Syzygium fruticosum*, *Spondius axillaris* and *Toona ciliata*. Our study sites were approximately 5–10 km apart from each other. All three sites were selected based on the frequent sighting of Red Giant Gliding Squirrels and site feasibility.

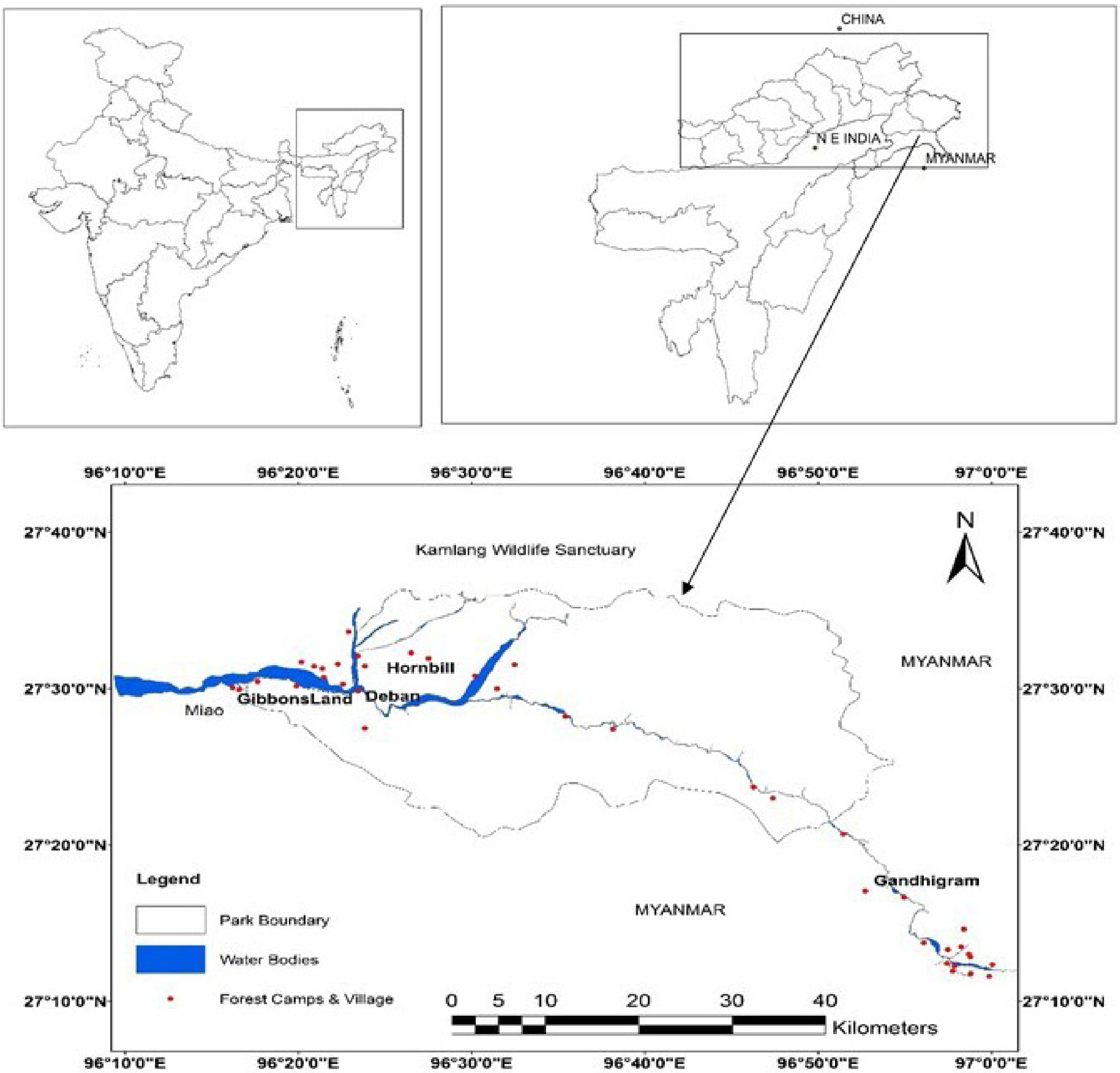

Figure 1. The study area (Namdapha National Park) and study locations (Kuladip Sarma and Parimal C. Ray).

Investigation of nesting cavities

The data on the squirrel nests was collected from October 2012 to September 2013. A minimum of 4–5 days were spent in the field per month during the study period to locate the nests. The nests were located by searching for gliding squirrels with headlamps (Energizer HDL33A2E (Energizer, USA)), during the evenings (17.00h) and early mornings (04.00h) when gliding squirrels usually leave and return to their nests (Shafique et al. 2009). Only those trails, however, were monitored which were marked for estimating encounter rates of the species. Also, opportunistic sightings of the nests were also included in the data whenever a nest was sighted. Upon locating the nesting site, the following nesting characteristics were recorded: tree species, total height of the nesting tree (m), height of the nest on the tree (m), diameter at breast height (DBH) (cm) of the tree, and canopy connectivity of the nesting tree. The height of the nest was measured using laser distance measurer (Bosch GLR225; accuracy ±1m (Robert Bosch GmbH, Germany). We followed Herlekar (2010) to determine canopy connectivity of the nesting tree, where connectivity was calculated based on the canopy shared by neighbouring trees. If the nesting tree was covered by canopy on four sides, we considered the canopy connectivity was 100%, whereas if nesting trees canopy had canopy connectivity on three, two, one, or no sides, connectivity was considered 75%, 50%, 25%, or 0%, respectively (Herlekar 2010). Additionally, to compare selected trees to nearby trees, we measured DBH (cm), tree height, and distance from nesting tree (m) of the four nearest trees to each individual nest tree. The nearest trees were identified based on the four imaginary quartiles which lie around the nesting tree. All the distances and tree heights were measured using a Nikon Rangefinder (Nikon 6x21 Forestry Pro, Nikon Corporation, Tokyo, Japan).

The lengths of census trails ranged between 0.5km and 2km. All the trails surveyed were pre-existing and no fresh trails were cut in order to minimise the disturbance in the area. Data on vegetation was collected along these trails using point centred-quarter method (Cottam & Curtis 1956). Absolute density and relative density of the trees were calculated following Mitchell (2010) where the absolute density of a species was estimated as the proportion of quarters where the species was found.

RESULTS

We observed Red Giant Gliding Squirrels using a total of 27 nests during the study and also found that the Red Giant Gliding Squirrel used eight tree species for nesting (Image 2): *Altingia excelsa* (n = 11), *Terminalia myriocarpa* (n=6), *Castanopsis indica* (n = 3), *Shorea assamica* (n=2), *Syzygium fruticosum* (n=2), *Cinnamomum bejolghota* (n=1), *Cinnamomum glaucescens* (n=1), and *Artocarpus chaplasha* (n=1). The nest trees exhibit low canopy connectivity, where most trees had <25% canopy connectivity (59.3% of nest trees), followed by 25.9% of nests with 50% canopy connectivity, and 14.8% of nests with connectivity >75%. The mean measurements of the nesting tree species are presented in Table 1.

Of the neighbouring trees (n=108) observed adjacent to nesting trees, ~93% (100 trees belonged to 25 species) were living trees and 7% (8 trees) were dead snags. And among the 25 species, nine species (n=61) were observed as feeding trees (Table 2). Of the 27 identified nesting trees, 24 had canopy connectivity with feeding trees. 12.5% of nesting trees were surrounded by four

Image 2. Nesting tree with juvenile of Red Giant Gliding Squirrel in Namdapha National Park, Arunachal Pradesh.

Table 1. Characteristics of nesting trees used by Red Giant Flying Squirrels in northern India during 2012-2013 (Data are mean±SE).

	Tree species	Family	Absolute density (individuals ha^{-1})	Mean basal Area (m^2 ha^{-1})	Mean height of the nesting tree (m)	Mean height of the nest (m)	Mean DBH of the nesting tree (cm)	Mean DBH of the nearest tree (cm)	Mean distance to the nearest tree (m)
1.	*Altingia excelsa*	Altingiaceae	17.4	0.22	31.1±1.3	16.5±1.02	79.2±11.64	40.5±1.74	12.6±0.76
2.	*Terminalia myriocarpa*	Combretaceae	10.2	0.33	31.5±0.95	17.8±0.95	70.8±5.45	40.14±2.19	12.08±0.9
3.	*Castanopsis indica*	Fagaceae	4.1	0.12	29.1±1.31	17.5±0.93	59.96±7.79	41±2.19	16.9±2.28
4.	*Shorea assamica*	Dipterocarpaceae	4.4	0.14	33.7±3.6	15.5±0.65	72.45±21.45	35.03±2.3	12.75±1.29
5.	*Syzygium fruticosum*	Myrtaceae	10.0	0.13	25.6±5.8	20.9±5.6	53.3±15.5	40.8±4.79	12.12±1.92
6.	*Cinnamomum bejolghota*	Lauraceae	0.8	0.20	28.9±0.0	17±0.0	69.4±0.0	37.82±1.88	15.5±3.22
7.	*Cinnamomum glaucescens*	Lauraceae	2.5	0.13	30.2±0.0	14.3±0.0	57.3±0.0	35.05±3.2	8.75±0.85
8.	*Artocarpus chaplasha*	Moraceae	1.0	0.08	41.3±0.0	35.2±0.0	52.5±0.0	37.42±3.7	10.5±0.95

Table 2. Tree species observed nearby *P. petaurista* nesting trees and their absolute and relative density and mean basal area in northern India during 2012–2013.

Tree species	Absolute density (individuals ha^{-1})	Relative density (individuals ha^{-1})	Mean basal area (m^2 ha^{-1})
Ailanthus grandis	1.1	0.8	0.22
*Altingia excelsa**	17.4	13.2	0.2
*Artocarpus chaplasha**	1.0	0.7	0.08
Biscofia javanica	2.8	2.2	0.23
*Castanopsis indica**	4.1	3.1	1.2
*Chukrasia tubularis**	2.8	2.2	0.2
Cinnamomum glaucescens	2.5	1.9	0.1
*Cinnamomum bejolghota**	0.8	0.6	0.2
Dipterocarpus macrocarpus	1.8	1.4	0.2
*Duabanga grandiflora**	2.6	1.9	0.2
Dysoxylum gobara	5.0	3.8	0.09
Elaeocarpus floribundus	0.7	0.6	0.06
Gmelina arborea	3.9	2.9	0.1
Gynocardia odorata	0.6	0.5	0.05
Macaranga denticulata	3.6	2.7	0.04
Magnolia hodgsonii	5.6	4.3	0.08
Mangifera sp.#	-	-	-
Mesua ferrea	1.9	1.4	0.03
*Neolamarckia cadamba**	1.2	0.9	0.08
Pterospermum canescens	1.3	0.9	0.2
Shorea assamica	4.4	3.3	0.15
Spondias axillaris	2.4	1.8	0.14
*Syzygium fruticosum**	10.0	7.6	0.13
*Terminalia myriocarpa**	10.2	7.7	0.33
Toona ciliata	3.0	2.3	0.07

* Feeding trees (as per Krishna et al. 2015).
# The data was not enumerated as the species did not lie in the vegetation plots.

Table 3. Comparison of nesting characters of *Petaurista* species globally.

	Species	Results	References
DBH of the nesting tree (cm)			
1.	*P. petaurista albiventer*	77.22±18.67 SD	Shafique et al. 2009
2.	*P. alborufus*	60–80	Lee et al. 1986
3.	*P. philippensis*	25–52	Lee et al. 1986
4	*P. philippensis*	301.6±69.88 SD	Koli et al. 2013
5.	*P. leucogenys*	20–140	Ando & Shiraishi 1983
6.	*P. petaurista*	70.6±0.98 SE	Present study
Height of the nest (m)			
1.	*P. philippensis*	10–12	Fan & Jiang 2009
2.	*P. philippensis*	10.07±3.22	Koli et al. 2013
3.	*P. petaurista*	17.8±0.89	Present study
Distance to the nearest tree (m)			
1.	*P. philippensis*	11.07±6.12	Koli et al. 2013
2.	*P. petaurista*	12.86±0.49	Present study

feeding trees, 33.3% were connected with three feeding trees, 45.8% were connected with two feeding trees, and 8.3% were connected with a single feeding tree.

DISCUSSION

Studying the life history traits and ecology of gliding squirrels is difficult due to their nocturnal habits and secretive nature. Our study is the only document presenting the nesting preferences of the Red Giant Gliding Squirrel in India till date. During the study period we observed Red Giant Gliding Squirrels nesting only in the cavities. This may be due to availability of tree cavities for nesting at our study site. Firstly, cavities may provide better protection than drey from predators, such as arboreal civets (Krishna et al. 2015). Secondly, the study area receives heavy rainfall during monsoon and thus cavity nests may offer more protection from inclement weather than drey nests. The Japanese Giant Gliding Squirrel *Petaurista leucogenys* drey's are observed in areas where there was scarcity of tree hollows (Haneda 1955; Tachibana 1957). Also, it was noted that the species preferred large trees with higher DBH for nesting. Similar observations were reported earlier in many other studies (see table 3). In general, gliding squirrels are reported to need tall mature forests for nesting as they are cavity nesters (Ransome et al. 1997) and are critically dependent on mature forests for food, and movement (Verbeylen et al. 2009). The gliding squirrel nests usually were several meters off the ground and located much lower from the point where branches originated (nearly 5–7 m), which may enable unobstructed access to the nest tree. Also, trees with less canopy connectivity were occupied more when compared to trees with more canopy connectivity which might be a reason to avoid predation pressure as discussed above. Gliding squirrels are predated by an array of mammals and birds (Taulman et al. 1998; Fan & Jiang 2009; Sun et al. 2009) and variables such as cavity height, entrance size, and condition of cavity trees are especially important factors for predator avoidance. To decrease predation risks, gliding squirrels select high cavities with small entrances in live trees (Wesolowski 2002; Ruczynski & Bogdanowicz 2005; Mitrus & Socko 2008; Kosinski et al. 2011).

In the present study, it was observed that the Red Giant Gliding Squirrel typically had one or more feeding trees located adjacent to a nest tree. During our study, it was observed that the individuals groomed initially after emerging from the nest and then glided to the nearest food tree for feeding unless the nesting tree is not a feeding tree. In a study conducted on Grizzled Giant Squirrel *Ratufa macroura* in southern India, gliding squirrels preferred nesting in areas with higher food tree availability (Herlekar 2010). In the Sierra Nevada Mountains, USA, Northern Gliding Squirrels *Glaucomys sabrinus* were reported to select specific tree species for nesting due to greater availability of hypogeal fungi food items associated with that tree species (Meyer et al. 2005). Red Giant Gliding Squirrel preference of nesting in *Altingia excelsa* and *Terminalia myriocarpa* in the present study could be due to high abundance of the listed two tree species and larger height of these tree species in the study area. Additionally, the branching of *Altingia excelsa* occurs higher on the trunk versus other species, providing tall naked trunks which provide easier access to nest cavities.

Though we compared the present study to various studies with regard to nesting habits of the giant gliding squirrels, understanding forest composition and structure, habitat quality, and anthropogenic disturbance, frequency of use of nests by species, duration of use need to be studied for better understanding of the nesting preferences. Also, from the present data, we cannot conclude the exact nesting preferences of the study species statistically due to smaller sample size. Habitat management, however, aimed at conserving cavity trees may be needed to conserve gliding squirrels, and those cavities and cavity trees that they selectively use should be preferentially conserved (Suzuki et al. 2013). Although our study indicates that large old trees of *Altingia excelsa* and *Terminalia myriocarpa* were typically selected, our small sample size has limited inference for making recommendations to forest management, however, it has to be noted that the species prefers old trees with natural cavities for nesting. On the whole, stress on additional studies to examine long-term nest use by the species and to compare characteristics between nest trees and a random sample of forest trees is highly recommended to better understand the nesting preference of the species.

REFERENCES

Ando, M. & S. Shiraishi (1983). The nest and nest-building behavior of the Japanese giant flying squirrel, *Petaurista leucogenys*. *Science Bulletin of Faculty of Agriculture Kyushu University* 38: 59–69 (in Japanese with English abstract).

Bendel, P.R. & J.E. Gates (1987). Home range and microhabitat partitioning of the southern flying squirrel (*Glaucomys volans*). *Journal of Mammalogy* 68(2): 243–255. https://doi.org/10.2307/1381463

Bonnet, X., R. Shine & O. Lourdais (2002). Taxonomic chauvinism. *Trends in Ecology and Evolution* 17: 1–3. https://doi.org/10.1016/S0169-5347(01)02381-3

Carey, A.B., T.M. Wilson, C.C. Maguire & B. L. Biswell (1997). Dens of northern flying squirrels in the Pacific Northwest. *Journal of Wildlife Management* 61: 684–699. https://doi.org/10.2307/3802176

Clark, J.A. & R.M. May (2002). Taxonomic bias in conservation research. *Science* 297(5579): 191–192. https://doi.org/10.1126/science.297.5579.191b

Cottam, G. & J.T. Curtis (1956). The use of distance measures in phytosociological sampling. *Ecology* 37: 451–460. https://doi.org/10.2307/1930167

Cowan, M.I. (1936). Nesting Habits of the Flying Squirrel *Glaucomys sabrinus*. *Journal of Mammalogy* 17: 58–60. https://doi.org/10.2307/1374553

Datta, A. & R. Nandini (2014). Sciurids. In: Johnsingh, A.J.T. & N. Manjrekar (eds.). *Mammals of South Asia, Vol. 2.* University Press, Hyderabad.

Diggins, C.A., C.A. Kelly & W.M. Ford (2015). A typical Den Use of Carolina Northern Flying Squirrels (*Glaucomys sabrinus coloratus*) in the southern Appalachian Mountains. *South Eastern Naturalist* 14(3): N44–N49. https://doi.org/10.1656/058.014.0303

Fan, P.F. & X.L. Jiang (2009). Predation on giant flying squirrels (*Petaurista philippensis*) by Black Crested Gibbons (*Nomascus concolor jingdongensis*) at Mt. Wuliang, Yunnan, China. *Primates* 50: 45–49. https://doi.org/10.1007/s10329-008-0110-5

Gerrow, J.S. (1996). Home range, habitat use, nesting ecology and diet of the northern flying squirrel in southern New Brunswick. M.S. Thesis, Acadia University, Wolfville, Nova Scotia, Canada.

Ghosh, A.K. (1987). Quantitative analysis of faunal resources of proposed Namdapha Biosphere Reserve. Zoological Survey of India, Calcutta, India.

Hackett, R.M., & J.F. Pagels (2003). Nest site characteristics of the endangered northern flying squirrel (*Glaucomys sabrinus coloratus*) in southwest Virginia. *American Midland Naturalist* 150: 321–331. https://doi.org/10.1674/0003-0031(2003)150[0321:NSCOTE]2.0.CO;2

Haneda, K. (1955). Nests of Nikko large flying squirrel built on trees. *Collecting and Breeding* 17: 72–74 (in Japanese).

Hanski, I.K., Stevens, P.C., P. Ihalempiä & V. Selonen (2000). Home-range size, movements, and nest-site use in the Siberian Flying Squirrel, *Pteromys volans*. *Journal of Mammalogy* 81(3): 798–809. https://doi.org/10.1644/1545-1542(2000)081<0798:HRSMAN>2.3.CO;2

Herlekar, I.R. (2010). Effect of canopy fragmentation on the patterns of habitat use of the grizzled giant squirrel *Ratufa macroura* in Cauvery Wildlife Sanctuary, Karnataka, India. Masters dissertation submitted to National Centre for Biological Sciences, Tata Institute of Fundamental Research, Bangalore, India.

Holloway, G.L. & J.R. Malcolm (2007). Nest-tree use by northern and southern flying squirrels in central Ontario. *Journal of Mammalogy* 88: 226–233. https://doi.org/10.1644/05-MAMM-A-368R2.1

Jayasekara, P., U.R. Weerasinghe, S. Wijesundara & S. Takatsuki (2007). Identifying diurnal and nocturnal frugivores in the terrestrial and arboreal layers of a tropical rain forest in Sri Lanka. *Ecotropica* 13: 7–15.

Koli, V., K.C. Bhatnagar & S.K. Sharma (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

Koprowski, J.L. & R. Nandini (2008). Global hotspots and knowledge gaps for tree and flying squirrels. *Current Science* 95: 851–856.

Kosinski, Z., Bilinska, E., J. Derezinski & M. Kempa (2011). Nest-sites used by Stock Doves Columba oenas: what determines their occupancy? *Acta Ornithology* 46: 155–163. https://doi.org/10.3161/000164511X625928

Krishna, C.M., A. Kumar, P.C. Ray, K. Sarma & J. Deka (2015). Investigating the Foraging Patterns and Distribution of Nocturnal Frugivores with Special Focus on Conservation Threats in Namdapha National Park, Arunachal Pradesh, India. Final report to the Rufford Small Grants Program (UK), 37pp.

Kumar, A., P.P. Mary & P. Bagchie (2009). Present distribution, population status, and conservation of Western Hoolock Gibbons *Hoolock hoolock* (Primates: Hylobatidae) in Namdapha National Park, India. *Journal of Threatened Taxa* 1(4): 203–209. https://doi.org/10.11609/JoTT.o1955.203-10

Lee, P.F., D.R. Progulske & Y.S. Lin (1986). Ecological studies on two sympatric Petaurista species in Taiwan. *Bulletin of Institute Zoology Academia Sinica* 25: 113–124.

Lindenmayer, D. (2002). *Gliders of Australia: A Natural History*. University of New South Wales Press, New South Wales, 160pp.

Martin, T.E. (1998). Are microhabitat preferences of coexisting species under selection and adaptive? *Ecology* 79: 656–670. https://doi.org/10.1890/0012-9658(1998)079 [0656:AMPOCS]2.0.CO;2

Menzel, J.M., Ford, W.M., J.W. Edwards & M.A. Menzel (2004). Nest tree use by the endangered Virginia northern flying squirrel in the central Appalachian Mountains. *American Midland Naturalist* 151: 355–368. https://doi.org/10.1674/0003-0031(2004)151 [0355:NTUBTE]2.0.CO;2

Meyer, M.D., D.A. Kelt & M.P. North (2005). Nest trees of northern flying squirrels in the Sierra Nevada. *Journal of Mammalogy* 86: 275–280. https://doi.org/10.1644/BEH-110.1

Mitchell, K. (2010). Quantitative analysis by the point-centered quarter method. arXiv preprint arXiv:1010.3303

Mitrus, C. & B. Socko (2008). Breeding success and nest-site characteristics of red-breasted flycatchers *Ficedula parva* in a primeval forest. *Bird Study* 55: 203–208. https://doi.org/10.1080/00063650809461523

Murali, K.C., A. Kumar, S. Khatiwara & C. Bonpo (2014). Further observations of Small-toothed Palm Civet *Arctogalidia trivirgata* in Namdapha National Park, Arunachal Pradesh, India. *Small Carnivore Conservation* 50: 45–46.

Nath, P.C., A. Arunachalam, M.L. Khan, K. Arunachalam & A.R. Barbhuiya (2005). Vegetation analysis and tree population structure of tropical wet evergreen forests in and around Namdapha National Park, northeast India. *Biodiversity Conservation* 14: 2109–2135. https://doi.org/10.1007/s10531-004-4361-1

Proctor, J., K. Haridasan & G.W. Smith (1998). How far north does low-land evergreen tropical rain forest go? *Global Ecology and Biogeography* 7: 141–146. https://doi.org/10.1111/j.1466-8238.1998.00270.x

Ransome, D.B. & T.P. Sullivan (1997). Food limitation and habitat preference of *Glaucomys sabrinus* and *Tamiasciurus hudsonicus*. *Journal of Mammalogy* 79: 538–549. https://doi.org/10.2307/1382905

Ray, P.C., A. Kumar, A. Devi, M.C. Krishna, M.L. Khan & W.Y. Brockelman (2015). Habitat characteristics and their effects on the density of groups of western hoolock gibbon (*Hoolock hoolock*) in Namdapha National Park, Arunachal Pradesh, India. *International Journal of Primatology* 36: 445–459. https://doi.org/10.1007/s10764-015-9834-4

Ruczynski, I. & W. Bogdanowicz (2005). Roost cavity selection by *Nyctalus noctula* and *N. leisleri* (Vespertilionidae, Chiroptera) in Bialowieza primeval forest, eastern Poland. *Journal of Mammalogy* 86: 921–930. https://doi.org/10.1644/1545-1542(2005)86[921:RCSBNN]2.0.CO;2

Shafique, C.M., S. Barkatib, T. Oshida & M. Ando (2009). Comparison of nest trees of two sympatric flying squirrel species in northern Pakistan. *Mammalian Biology* 74: 240–244. https://doi.org/10.1016/j.mambio.2009.01.005

Sun, Y.H., Y.K. Huang, W. H. Tsai, S.Y. Hong & C.C. Chen (2009). Breeding-season diet of the mountain hawk-eagle in southern Taiwan. *Journal of Raptor Research* 43: 159–163. https://doi.org/10.3356/JRR-08-86.1

Suzuki, K., M. Sagawab & Y. Hisashi (2013). Nest cavity selection by the Siberian flying squirrel *Pteromys volans*. *Hystrix Italian Journal of Mammology* 24: 187–189. https://doi.org/10.4404/hystrix-24.2-8975

Tachibana, S. (1957). Observation on habit of *Petaurista leucogenys nikkonis* Thomas, near Iinokawa. *Journal of Mammology Society of Japan* 1: 51–55 (in Japanese).

Taulman, J.F. (1999). Selection of nest trees by southern flying squirrels (Sciuridae: *Glaucomys volans*) in Arkansas. *Journal of Zoology* 248: 369–377.

Taulman, J.F., K.G. Smith & R.E. Thill (1998). Demographic and behavioral responses of southern flying squirrels to experimental logging in Arkansas. *Ecological Applications* 8: 1144–1155. https://doi.org/10.1890/1051-0761(1998)008[1144:DABROS]2.0.CO;2

Traill, B.J. & A. Lill (1997). Use of tree hollows by two sympatric gliding possums, the squirrel glider, *Petaurus norfolcensis* and the sugar glider, *P. breviceps*. *Australian Mammalogy* 20: 79–88.

Verbeylen, G., L.A. Wauters, L. De Bruyn & E. Matthysen (2009). Woodland Fragmentation affects space use of Eurasian red squirrels. *Acta Oecologica* 35: 94–103. https://doi.org/10.1016/j.actao.2008.08.005

Weigl, P.D. (1978). Resource overlap, interspecific interactions and the distribution of the flying squirrel, *Glaucomys volans* and *Glaucomys sabrinus*. *American Midland Naturalist* 100: 83–96. https://doi.org/10.2307/2424779

Weigl, P.D. & D.W. Osgood (1974). Study of the northern flying squirrel, *Glaucomys sabrinus*, by temperature telemetry. *American Midland Naturalist* 92: 482–486. https://doi.org/10.2307/2424313

Wesolowski, T. (2002). Anti-predator adaptations in nesting Marsh Tits *Parus palustris*: the role of nest-site security. *Ibis* 144: 593–601. https://doi.org/10.1046/j.1474-919X.2002.00087.x

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