



# Nesting Site Preferences of *Ratufa indica indica* in the Umblebyle Range Forest, Bhadravathi Division, Shimoga, Karnataka

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## ABSTRACT

Malabar Giant Squirrel (*Ratufa indica indica*) is one of the four subspecies endemic to India (Abdulali 1952), common to northern and central Western Ghats among species *Ratufa indica* belonging to Subfamily Ratuinae. The study was designed to analyze the nest tree preferences of animals in the dry deciduous forests of the Umblebyle range, Shimoga, Karnataka (South India) during February, March, and April 2021, surveying 20 transects covering a distance of 47.7 km. Nest tree preferences were assessed by observing 406 dreys (nests) on 385 trees covering an area of 8350.89 ha. The nest trees came from 20 families and 41 species, with 12 tree species in the Family Fabaceae and 84 trees in the *Terminalia paniculata* having the highest preference. The Squirrels showed the highest preference for deciduous trees over semi-evergreen and evergreen trees. The most preferred tree height and nest height ranged between 11-20m, including 87.53% of nesting trees and 83.89% of nests, respectively. The average nest height was estimated to be 14.73 ( $\pm 3.311$ ) m, with a minimum and maximum height of 7 m and 28 m, respectively. The difference between average tree height and average nest height was 1.512m.

## INTRODUCTION

*Ratufa indica indica*, also referred to as Malabar Giant Squirrel (MGS) from the sub-family Ratuinae, is a cat-sized diurnal (Nowak 1999), arboreal, upper canopy dwelling species rarely moving to the ground (Baskaran et al. 2011), found in northern and central Western Ghats, at an elevation of 180-2300m from Mumbai to Karnataka inhabiting deciduous, mixed deciduous and moist evergreen forests (Prater 1980, Aparajita & Goyal 1996). The animal is listed in Appendix II of CITES, 2005, Least Concern category of the IUCN red list, Schedule II of Wildlife (Protection) Act, 1972. It is an upper canopy dwelling species (Ramachandran 1988) active in the early morning and evening hours, resting during mid-day (Basantha & Ajay 2015), locally known as Kendalilu. They construct more than one drey within a single breeding season (Pradhan et al. 2017), usually in high canopies using leaves and twigs in profusely branched tall trees (Basantha & Ajay 2015).

In the past, similar studies have been made on the nesting of *Ratufa indica* in places like Mudumalai Tiger

Reserve (Nagarajan et al. 2011), Karalpat Wildlife Sanctuary (Pradhan et al. 2017), Dalma wildlife sanctuary (Mishra et al. 2011), Sitanadi wildlife Sanctuary (Ravi 2008) Kuldiha wildlife sanctuary (Basantha & Ajay 2015). As nesting and feeding are two vital aspects of animal ecology and no previous study has been conducted so far in the Umblebyle range forest, in the present study, we documented nest tree preferences of the animal in the study area.

## STUDY AREA

The Umblebyle Range Forest (Fig. 1) is located in the foothills of Western Ghats, situated in the southwestern part of the Bhadravathi division forest, Shimoga district, Karnataka, within the geographic coordinates of 14°30'0" to 13°43'0" N and 75°30'0" to 75°47'30" E. The area enjoys a tropical climate for the whole of the year. The annual average rainfall is around 769.4 mm, with minimum and maximum temperatures of 20°C and 31°C, respectively. The main watershed systems covering the area include Tunga and Bhadra rivers draining the (South-South-East) SSE part and are the main seasonal river. The location's topography is undulating hills and hillocks with a dry deciduous forest. The area's relief varies between 500 and 1520 m above (Mean Sea Level) MSL. The area comprises 20 villages

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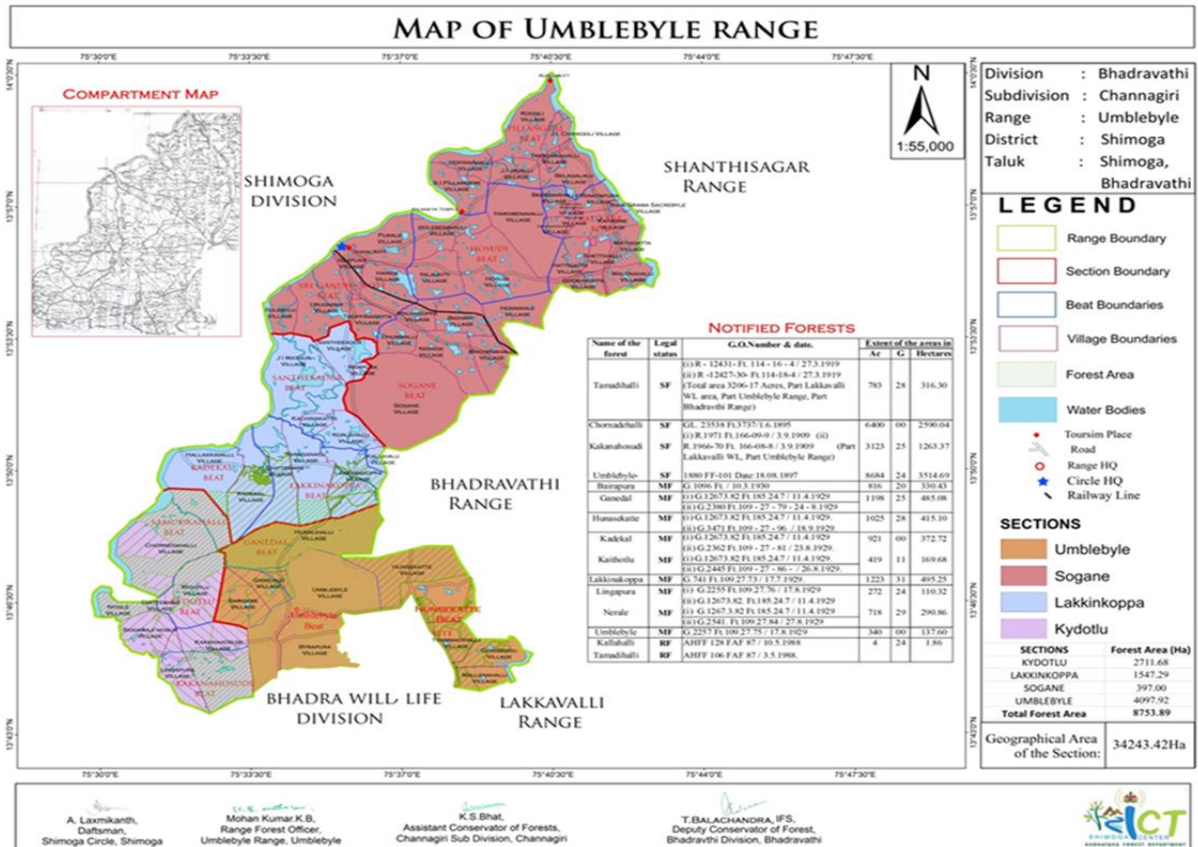


Fig. 1: Map of Umbleyle Range.

and four beats, namely Umbleyle, Kydotlu, Lakkinkoppa, and Sogane beats, among which three comprised forest cover, namely Umbleyle, Kydotlu, and Lakkinkoppa beats. Prominent trees include *Terminalia paniculata*, *Terminalia tomentosa* and *Tectona grandis*.

## MATERIALS AND METHODS

The survey was carried out using the Line transect method (Altmann 1975, Buckland et al. 1993, Devcharan 2008). The nesting behavior documentation was done from February 2021 to April 2021, walking in line transects laid using Arc Gis Software to cover the entire study area, keeping the transects equidistant, covering a distance of 47.7 km walking over 20 transects ranging from 2-3 km each. The transects were walked during the morning 06:00 am – 10:00 am as the animal is active during this period (Pradhan 2017). The number of nests and nesting trees species were documented considering different parameters like tree species, the height of the tree (Girth at Breast Height) GBH, number of nests, the height of the nest from the ground, age of the nest, and (Global Positioning System) GPS location of the nest

(Basantha & Ajay 2015). An Olympus 10 × 50 binocular was used to observe the nests and the species. The common names of the tree species were recorded with the aid of the local personnel, and their scientific names were ascertained from the book Endemic Woody Plants of the Western Ghats (Navendu 2017).

## RESULTS

A total of 406 dreys were observed on 385 nesting trees that included 41 different species belonging to 20 families (Tables 1, 2, and 3; Fig. 2, 3 and 4). Among the 20 families recorded, the animal preferred tree species of certain families over others. Based on the variety of tree preference for nesting, Family Fabaceae (29.26%) was the most preferred including 12 tree species namely *Acacia auriculiformis*, *Albizia odoratissima*, *Albizia procera*, *Bahunia malabarica*, *Butea monosperma*, *Cassia siamea*, *Dalbergia latifolia*, *Dalbergia paniculata*, *Pterocarpus marsupium*, *Pongamia pinnata*, *Tamrindus indica* and *Xylocarpus xylocarpa* followed by Family Combretaceae (12.19%) including 5 tree species namely *Anogeissus latifolia*, *Terminalia arjuna*, *Terminalia*

*bellerica*, *Terminalia paniculata* and *Terminalia tomentosa*, Families Malvaceae and Rubiaceae with equally 14.63% each having 3 species each *Bombax ceiba*, *Grewia tillifolia*, *Kydia calycina* and *Adina cordifolia*, *Hymenodictyon excelsum* and *Mitragina parviflora* respectively. These are followed by Families Lamiaceae and Moraceae contributing 9.75% each having 2 tree species *Gmelina arborea*, *Tectona grandis* and *Ficus bengalensis* and *Ficus tsiela* respectively, and 14 families contributing 34.14% that included 1 tree species each namely *Semecarpus anacardium* from Family Anacardiaceae, *Saccopetalum tomentosum* from Family Annonaceae, *Sterospermum xylocarpus* from Family Bignoniaceae, *Cordia macleodii* from Family Boraginaceae, *Garuga pinnata* from Family Burseraceae, *Dillenia pentagyna* from Family Dilleniaceae, *Diospyros monata* from Family Ebenaceae, *Careya arborea* from Family Lecythidaceae, *Strychnos nux-vomica* from Family Loganiaceae, *Lagerstroemia lanceolata* from Family Lythraceae, *Syzigium cumini* from Family Mythraceae, *Chloroxylon swietenia* from Family Rutaceae, *Schleichera trijunga* from Family Sapindaceae and *Bassia latifolia* from Family Sapotaceae.

Among the total 41 tree species recorded (Tables 1, 2 & 3), the nesting of the animal indicated preferences for some species more than others. *Terminalia pinaculata* (84 trees, 21.81%) was the most preferred tree species followed by *Terminalia tomentosa* (45 trees, 11.68%), *Schleichera trijunga* (41 trees, 10.64%), *Pterocarpus marsupium* (34 trees, 8.83%), *Tectona grandis* (28 trees, 7.27%), *Dillenia pentagyna* (20 trees, 5.19), *Terminalia bellerica* and *Anogeissus latifolia* (14 trees each, 7.27%), *Dalbergia latifolia* (12 trees, 3.11%), *Adina cordifolia* (11 trees, 2.85%), *Kydia calycina* (9 trees, 2.33%), *Xylia xylocarpa* and *Lagerstroemia lanceolata* (7 trees each, 3.63%), *Albizia odoratissima* and *Grewia tillifolia* (6 trees each, 3.11%), *Garuga pinnata* and *Bahunia malabarica* (4 trees each, 2.07%), *Ficus benghalensis*, *Hymenodictyon excelsum*, *Semecarpus anacardium*, *Dalbergia paniculata* and *Saccopetalum tomentosum* (3 trees each, 3.89%), *Tamrindus indica*, *Cardia macleodii*, *Sterospermum xylocarpus* and *Chloroxylon swietenia* (2 trees each, 2.07%), *Acacia auriculiformis*, *Ficus tsiela*, *Mitragina parviflora*, *Albizia procera*, *Bombax ceiba*, *Terminalia arjuna*, *Pongamia pinnata*, *Diospyros montana*, *Strychnos nux-vomica*, *Careya arborea*, *Butea monosperma*, *Cassia siamea*, *Gmelina arborea*, *Bassia latifolia* and *Syzigium cumini* (1 tree each, 4.15%).

During this study, 92.36% (375 number) of dreys were new, and 7.63% (31 number) were old. The animal preferred deciduous over evergreen and semi-evergreen trees (Tables

1, 2 & 3). Among 41 nesting tree species, 32 were deciduous, contributing 78.04%; 5 were evergreen, contributing 12.19% and 4 were semi-evergreen, contributing 9.75%. Tree species that showed multiple nesting include *Dillenia pentagyna*, *Garuga pinnata*, *Pterocarpus marsupium*, *Schleichera trijunga*, *Tamrindus indica*, and *Terminalia pinaculata*. (Figs. 5, 6, 7).

Among 41 tree species recorded in all the study sites, Umblebyle beat (Table 1), was found to have highest nesting tree species diversity with 28 tree species namely *Adina cordifolia*, *Anogeissus latifolia*, *Bahunia malabarica*, *Bassia latifolia*, *Bombax ceiba*, *Butea monosperma*, *Cassia siamea*, *Chloroxylon swietenia*, *Cordia macleodii*, *Dalbergia paniculata*, *Dalbergia latifolia*, *Dillenia pentagyna*, *Diospyros monata*, *Ficus bengalensis*, *Ficus tsiela*, *Garuga pinnata*, *Hymenodictyon excelsum*, *Lagerstroemia lanceolata*, *Pongamia glabra*, *Pterocarpus marsupium*, *Schleichera trijunga*, *Tamrindus indica*, *Tectona grandis*, *Terminalia arjuna*, *Terminalia bellerica*, *Terminalia paniculata*, *Terminalia tomentosa* and *Xylia xylocarpa* followed by Lakkinkoppa beat (Table 2) with 25 tree species namely *Acacia auriculiformis*, *Adina cordifolia*, *Albizia odoratissima*, *Albizia procera*, *Anogeissus latifolia*, *Bahunia malabarica*, *Careya arborea*, *Chloroxylon swietenia*, *Cordia macleodii*, *Dalbergia latifolia*, *Ficus bengalensis*, *Garuga pinnata*, *Kydia calycina*, *Lagerstroemia lanceolata*, *Mitragina parviflora*, *Pterocarpus marsupium*, *Saccopetalum tomentosum*, *Schleichera trijunga*, *Sterospermum xylocarpus*, *Strychnos nux-vomica*, *Syzigium cumini*, *Tectona grandis*, *Terminalia bellerica*, *Terminalia paniculata* and *Terminalia tomentosa* while Kydotlu beat (Table 3) had least tree species diversity with 13 tree species namely *Grewia tillifolia*, *Dalbergia latifolia*, *Dillenia pentagyna*, *Gmelina arborea*, *Kydia calycina*, *Lagerstroemia lanceolata*, *Pterocarpus marsupium*, *Schleichera trijunga*, *Semecarpus anacardium*, *Tectona grandis*, *Terminalia paniculata*, *Terminalia tomentosa* and *Xylia xylocarpa*.

*Dalbergia latifolia*, *Pterocarpus marsupium*, *Terminalia pinaculata*, *Schleichera trijunga*, *Terminalia tomentosa*, *Lagerstroemia lanceolata*, and *Tectona grandis* tree species were common to all the three beats. *Kydia calycina* was the only tree species common to Lakkinkoppa and Kydotlu beats. Similarly, *Xylia xylocarpa* and *Dillenia pentagyna* were common to Umblebyle and Kydotlu beats. Also, *Cordia macleodii*, *Ficus benghalensis*, *Bahunia malabarica*, *Anogeissus latifolia*, *Garuga pinnata*, *Chloroxylon swietenia*, *Terminalia bellerica*, and *Adina cordifolia* were tree species common to Lakkinkoppa and Umblebyle beats. There were tree species endemic to specific beats, *Gmelina arborea*, *Grewia tillifolia* and *Semecarpus anacardium*

were endemic to Kydotlu beat, while *Mitragina perviflora*, *Acacia auriculiformis*, *Albizia procera*, *Steropermum xylocarpus*, *Strychnos nux-vomica*, *Careya arborea*, *Syzigium cumini*, and *Saccopetalum tomentosum* were endemic to Lakkinkoppa beat. The tree species *Ficus tsiela*, *Bombax ceiba*, *Hymenodictyon excelsum*, *Terminalia arjuna*, *Pongamia pinnata*, *Tamrindus indica*, *Diospyros montana*, *Terminalia tomentosa*, *Butea monosperma*,

*Dalbergia paniculata*, *Cassia siamea* and *Bassia latifolia* were endemic to Umblebyle beat.

In all three beats, the average tree height was estimated to be 16.18 ( $\pm$  3.430) m, with minimum and maximum tree heights of 8m and 30m, respectively. The most preferred tree height for nesting was 11-20m, which supported 87.53%. Trees less than 11m supported 8.57%, and trees more than 20m supported 3.89%. The average nest height was estimated

Table 1: Tree Species, Tree height, Nest height, and GBH in Umblebyle beat.

Sl. No.	Family	Scientific names	Habitat	Tree Height Avg (m)Z	Nest height Avg (m)	GBH Avg (m)	No of trees	RA Nest tree %	No of nest	RA of nest %
1.	Boraginaceae	<i>Cardia macleodii</i>	D	22	20	1.3	1	0.61	1	0.58
2.	Burseraceae	<i>Garuga pinnata</i>	D	12	11	0.8	1	0.61	1	2.33
3.	Combretaceae	<i>Anogeissus latifolia</i>	D	16.5 $\pm$ 2.121	15 $\pm$ 1.414	0.75 $\pm$ 0.070	2	1.22	2	0.58
4.	Combretaceae	<i>Terminalia arjuna</i>	E	15	14	1	1	0.61	1	0.58
5.	Combretaceae	<i>Terminalia paniculata</i>	D	15.8 $\pm$ 4.507	14 $\pm$ 4.305	0.8 $\pm$ 0.159	51	31.28	57	1.16
6.	Combretaceae	<i>Terminalia tomentosa</i>	D	14.7 $\pm$ 3.283	13.3 $\pm$ 2.887	0.7 $\pm$ 0.135	23	13.49	23	1.75
7.	Combretaceae	<i>Terminalia bellerica</i>	SE	13 $\pm$ 3.605	11.3 $\pm$ 3.214	0.8 $\pm$ 0.173	3	1.84	3	0.58
8.	Dilleniaceae	<i>Dillenia pentagyna</i>	D	17.3 $\pm$ 2.081	16 $\pm$ 1.732	0.95	3	1.84	3	0.58
9.	Ebenaceae	<i>Diospyros monata</i>	D	10	9	0.7	1	0.61	1	8.77
10.	Fabaceae	<i>Tamrindus indica</i>	E	16	14.5 $\pm$ 0.707	1.1	2	1.22	2	0.58
11.	Fabaceae	<i>Bahunia malabarica</i>	SE	14.5 $\pm$ 7.778	13.75 $\pm$ 7.424	0.7 $\pm$ 0.141	2	1.22	2	33.33
12.	Fabaceae	<i>Dalbergia latifolia</i>	D	13.25 $\pm$ 2.753	12 $\pm$ 2.44	0.8 $\pm$ 0.15	4	2	4	2.33
13.	Fabaceae	<i>Pongamia pinnata</i>	D	16	14	0.7	1	0.61	1	0.58
14.	Fabaceae	<i>Pterocarpus marsupium</i>	D	15.6 $\pm$ 3.352	14 $\pm$ 3.070	0.8 $\pm$ 0.148	15	9.2	15	0.58
15.	Fabaceae	<i>Xylia xylocarpa</i>	D	15	14	0.6	1	0.61	1	1.75
16.	Fabaceae	<i>Butea monosperma</i>	D	10	9	0.7	1	0.61	1	12.86
17.	Fabaceae	<i>Dalbergia paniculata</i>	D	17	20 $\pm$ 18.666	1 $\pm$ 0.2	3	1.84	3	0.58
18.	Fabaceae	<i>Cassia siamea</i>	E	10	9	0.6	1	0.61	1	12.86
19.	Lamiaceae	<i>Tectona grandis</i>	D	13.7 $\pm$ 3.683	12.2 $\pm$ 3.860	0.914 $\pm$ 0.110	7	4.29	7	0.58
20.	Lythraceae	<i>Syzigium cumini</i>	E	17 $\pm$ 1.414	16.2 $\pm$ 1.767	0.85 $\pm$ 0.070	2	1.22	2	1.16
21.	Malvaceae	<i>Bombax ceiba</i>	D	15	13	0.8	1	0.61	2	1.16
22.	Moraceae	<i>Ficus bengalensis</i>	E	13 $\pm$ 4.242	11.5 $\pm$ 3.535	1	2	1.22	2	1.16
23.	Moraceae	<i>Ficus tsiela</i>	D	25	21	1.3	1	0.61	1	1.75
24.	Rubiaceae	<i>Hymenodictyon excelsum</i>	D	16.6 $\pm$ 3.055	14.3 $\pm$ 3.214	0.76 $\pm$ 0.144	3	1.84	3	0.58
25.	Rubiaceae	<i>Adina cordifolia</i>	D	16 $\pm$ 3.464	14.1 $\pm$ 3.184	1 $\pm$ 0.343	7	4.29	7	1.75
26.	Rutaceae	<i>Chloroxylon sweetenia</i>	D	10	9	0.6	1	0.61	1	4.09
27.	Sapindaceae	<i>Schleichera trijunga</i>	D	12 $\pm$ 1.732	11 $\pm$ 1.732	0.9 $\pm$ 0.264	22	13.49	22	4.09
28.	Sapotaceae	<i>Bassia latifolia</i>	D	10	9	0.7	1	0.61	1	0.58
							163		170	

RA- Relative Abundance, D- Deciduous, E- Evergreen, SE- Semi-evergreen.

to be 14.73 ( $\pm$  3.311) m, with minimum and maximum nest heights of 7m and 28m, respectively. The most preferred nest height was 11-20m, which supported 83.89%. Trees with a height of less than 11m supported 12.20%, and trees with more than 20m supported 3.89%. The average GBH was estimated to be 0.912 ( $\pm$  0.373) m, with minimum and

maximum GBH of 0.2m and 3m, respectively. The most preferred GBH was from 0.6-1.5m, which supported 87.27% of the nest. Trees with GBH of less than 0.5m supported 9.09%, and trees with more than 1.5m supported 3.37% of the nest. The difference between average tree height and average nesting height was estimated at 1.512 m.

Table 2: Tree Species, Tree height, Nest height, and GBH in Lakkinkoppa beat.

Sl. No.	Family	Species	Habitat	Tree Height Avg (m)	Nest height Avg (m)	GBH Avg (m)	No of trees	RA Nest tree %	No of nest	RA of nest %
1.	Bignoniaceae	<i>Sterospermum xylocarpus</i>	D	13 $\pm$ 1.414	11 $\pm$ 1.414	0.5	2	1.4	2	1.36
2.	Boraginaceae	<i>Cardia macleodii</i>	D	12	11	0.4	1	0.7	1	0.68
3.	Burseraceae	<i>Garuga pinnata</i>	D	13 $\pm$ 1.73	11.3 $\pm$ 2.309	0.83 $\pm$ 0.057	3	2.11	5	3.42
4.	Combretaceae	<i>Anogeissus latifolia</i>	D	16.5 $\pm$ 2.314	15.16 $\pm$ 2.367	0.85 $\pm$ 0.305	12	8.4	12	8.21
5.	Combretaceae	<i>Terminalia paniculata</i>	D	16 $\pm$ 2.190	14 $\pm$ 2.182	0.75 $\pm$ 0.439	16	11.2	16	10.95
6.	Combretaceae	<i>Treminalia toman-tosa</i>	D	15.6 $\pm$ 3.089	14.166 $\pm$ 3.451	0.66 $\pm$ 0.250	18	12.67	18	12.32
7.	Combretaceae	<i>Terminalia bell-erica</i>	SE	17.363 $\pm$ 3.139	16 $\pm$ 3.0331	1.03 $\pm$ 0.382	11	7.74	11	7.53
8.	Fabaceae	<i>Acacia auriculi-formis</i>	E	15	14	0.4	1	0.7	1	0.68
9.	Fabaceae	<i>Bahunia mala-barica</i>	SE	15 $\pm$ 1.414	14 $\pm$ 1.414	0.95 $\pm$ 0.070	2	1.4	2	1.36
10.	Fabaceae	<i>Dalbergia latifolia</i>	D	16.28 $\pm$ 2.429	15.28 $\pm$ 2.429	0.957 $\pm$ 0.427	7	4.92	7	4.79
11.	Fabaceae	<i>Albizia odoratis-sima</i>	D	22 $\pm$ 3.651	20 $\pm$ 3.670	1.7 $\pm$ 0.730	7	4.92	7	4.79
12.	Fabaceae	<i>Albizia procera</i>	D	20	18	0.7	1	0.7	1	0.68
13.	Fabaceae	<i>Pterocarpus mar-supium</i>	D	17.2 $\pm$ 3.192	15.3 $\pm$ 3.122	0.94 $\pm$ 0.287	9	6.33	9	6.16
14.	Lamiaceae	<i>Tectona grandis</i>	D	17.85 $\pm$ 2.497	16.4 $\pm$ 2.542	0.86 $\pm$ 0.178	20	14.08	20	13.69
15.	Lecythidaceae	<i>Careya arborea</i>	D	19	18	0.7	1	0.7	1	0.68
16.	Loganiaceae	<i>Strychnos nux-vomica</i>	D	13	12	0.8	1	0.7	1	0.68
17.	Lyrtaeae	<i>Lagerstroemia lanceolata</i>	D	16 $\pm$ 1.732	15 $\pm$ 1.732	0.9 $\pm$ 0.173	3	2.11	3	2.05
18.	Malvaceae	<i>Kydia calycina</i>	D	15.87 $\pm$ 2.356	14 $\pm$ 2.203	0.91 $\pm$ 0.295	8	5.63	8	5.4
19.	Moraceae	<i>Ficus bengalensis</i>	SE	20	18	3	1	0.7	1	0.68
20.	Mythraceae	<i>Syzigium cumini</i>	E	15	14	2	1	0.7	1	0.68
21.	Rubiaceae	<i>Mitragina pervi-flora</i>	D	15	14	0.7	1	0.7	1	0.68
22.	Rubiaceae	<i>Saccopetalum tomentosum</i>	D	18 $\pm$ 2	16 $\pm$ 1.527	0.966 $\pm$ 0.057	3	2.11	3	2.05
23.	Rubiaceae	<i>Adina cordifolia</i>	D	17.75 $\pm$ 2.629	16.75 $\pm$ 2.629	1 $\pm$ 0.687	4	2.81	4	2.73
24.	Rutaceae	<i>Chloroxylon sweitenia</i>	D	18	17	1	1	0.7	1	0.68
25.	Sapindaceae	<i>Schleichera trijunga</i>	D	19.1 $\pm$ 4.648	17.7 $\pm$ 4.465	1.4 $\pm$ 0.787	9	6.33	11	7.53
							142		146	

RA- Relative Abundance, D- Deciduous, E- Evergreen, SE- Semi-evergreen.

Table 3: Tree Species, Tree height, Nest height, and GBH in Kydotlu beat.

Sl. No.	Family	Scientific names	Habitat	Tree Height Avg (m)	Nest height Avg (m)	GBH Avg (m)	No of trees	RA Nest tree %	No of nest	RA of nest %
1.	Anacardiaceae	<i>Semecarpus anacardium</i>	D	13	12	0.7 ± 1.359	3	3.75	3	3.37
2.	Combretaceae	<i>Terminalia paniculata</i>	D	17.529 ± 2.095	16.1 ± 2.007	0.9 ± 0.560	17	21.25	17	19.1
3.	Combretaceae	<i>Terminalia tomentosa</i>	D	17.4 ± 2.509	16 ± 2.345	0.79 ± 0.300	5	6.25	5	5.61
4.	Dilleniaceae	<i>Dillenia pentagyna</i>	D	15.3 ± 2.089	14.4 ± 2.034	0.8 ± 0.134	17	21.25	21	23.59
5.	Fabaceae	<i>Dalbergia latifolia</i>	D	15	14	0.7	1	1.25	1	1.12
6.	Fabaceae	<i>Pterocarpus marsupium</i>	D	17 ± 1.247	18.5 ± 1.354	0.92 ± 0.091	10	12.5	13	14.6
7.	Fabaceae	<i>Xylocarpus xylocarpa</i>	D	17.833 ± 2.401	16.3 ± 1.861	0.8 ± 0.040	6	7.5	6	6.74
8.	Lamiaceae	<i>Gmelina arborea</i>	D	20	18	0.8	1	1.25	1	1.12
9.	Lamiaceae	<i>Tectona grandis</i>	D	15	14	0.8	1	1.25	1	1.12
10.	Lythraceae	<i>Lagerstroemia lanceolata</i>	D	18 ± 2.828	16 ± 4.242	1.15 ± 0.494	2	2.5	2	2.24
11.	Malvaceae	<i>Kydia calycina</i>	D	10	9	0.4	1	1.25	1	1.12
12.	Malvaceae	<i>Grewia tillifolia</i>	D	16 ± 2.683	14.5 ± 2.258	0.9 ± 0.109	6	7.5	6	6.74
13.	Sapindaceae	<i>Schleichera trijunga</i>	SE	16.4 ± 2.547	15.2 ± 2.573	1.2 ± 0.385	10	12.25	12	13.48
							80		89	

RA- Relative Abundance, D- Deciduous, E- Evergreen, SE- Semi-evergreen.

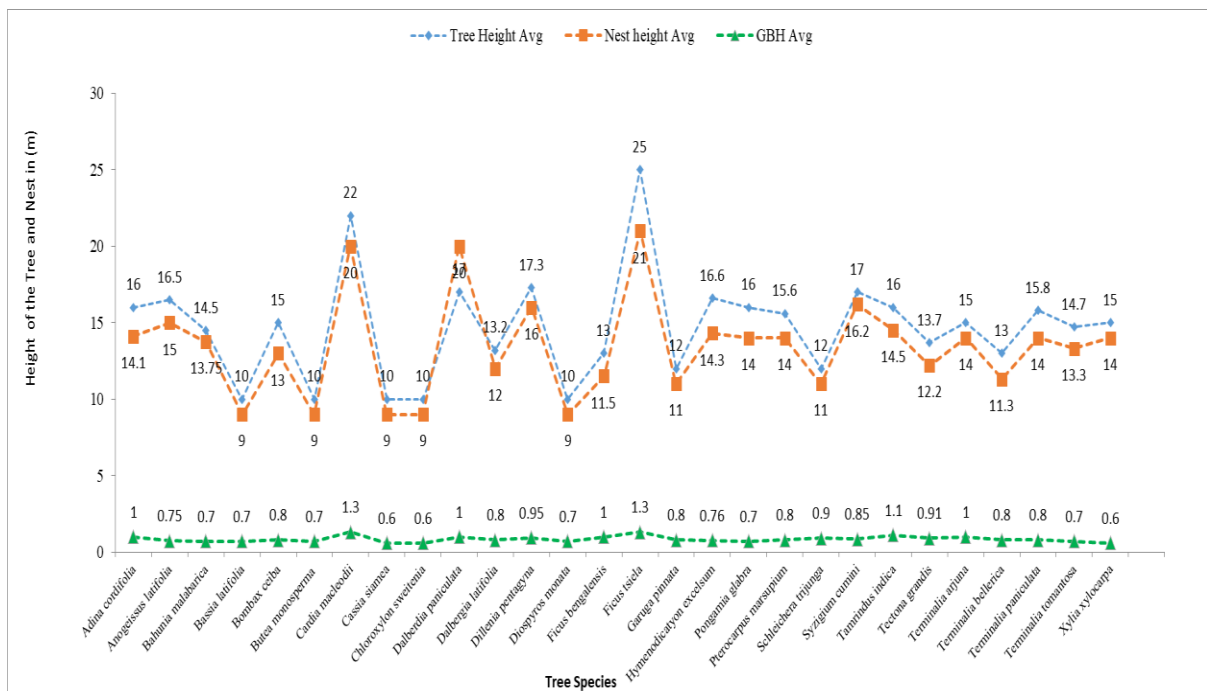


Fig. 2: Tree height, Nest height, and GBH of trees in Umbleybeat.

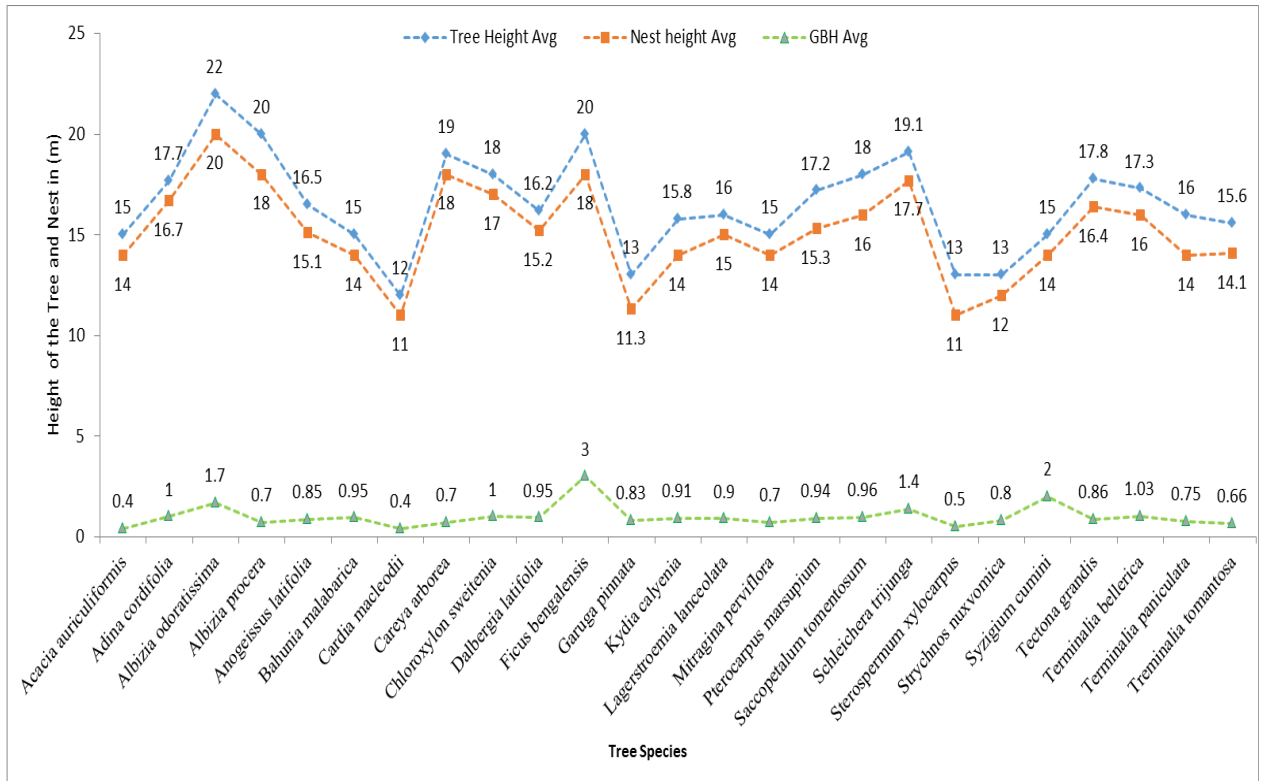


Fig. 3: Tree height, Nest height, and GBH of trees in Lakkinkoppa beat.

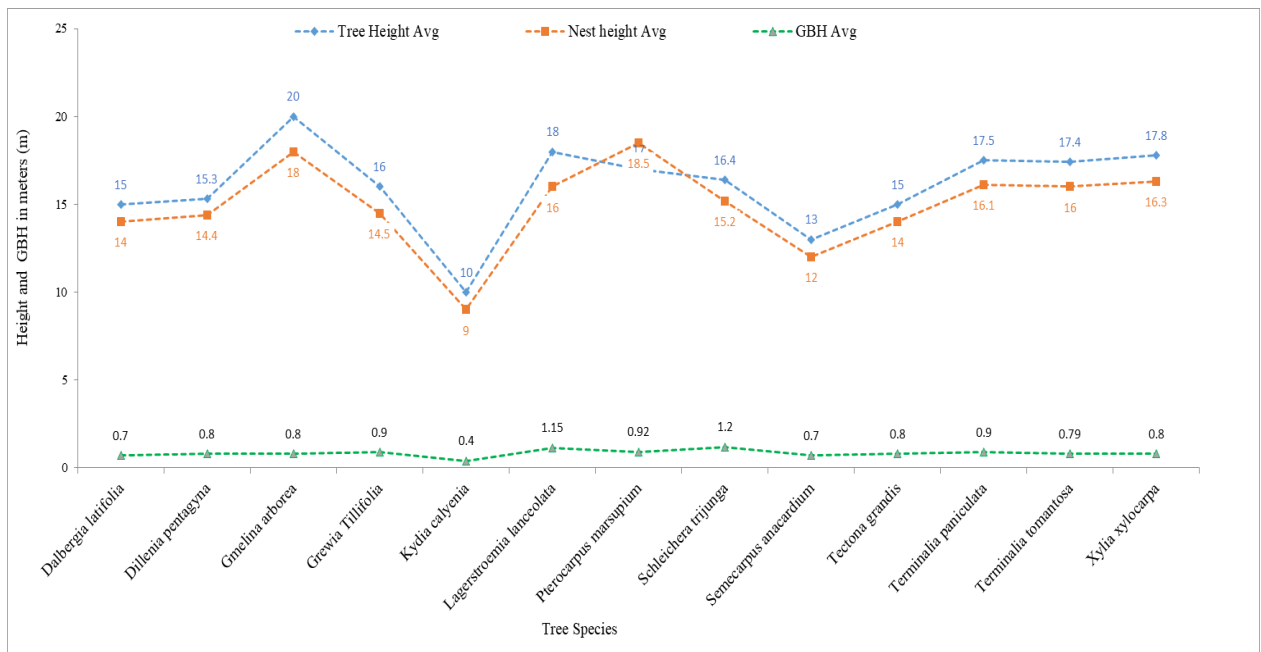


Fig. 4: Tree height, Nest height, and GBH of trees in Kydotlu beat.

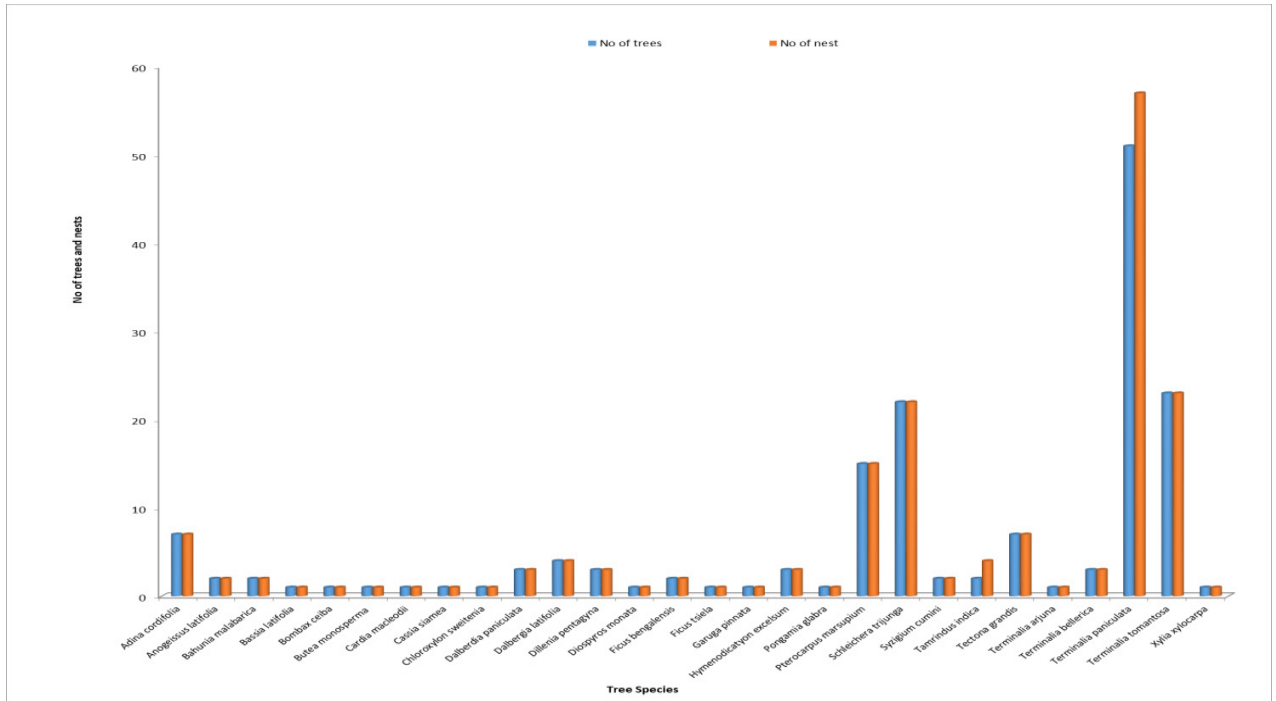


Fig. 5: Number of trees v/s number of dreys in Umbley beat.

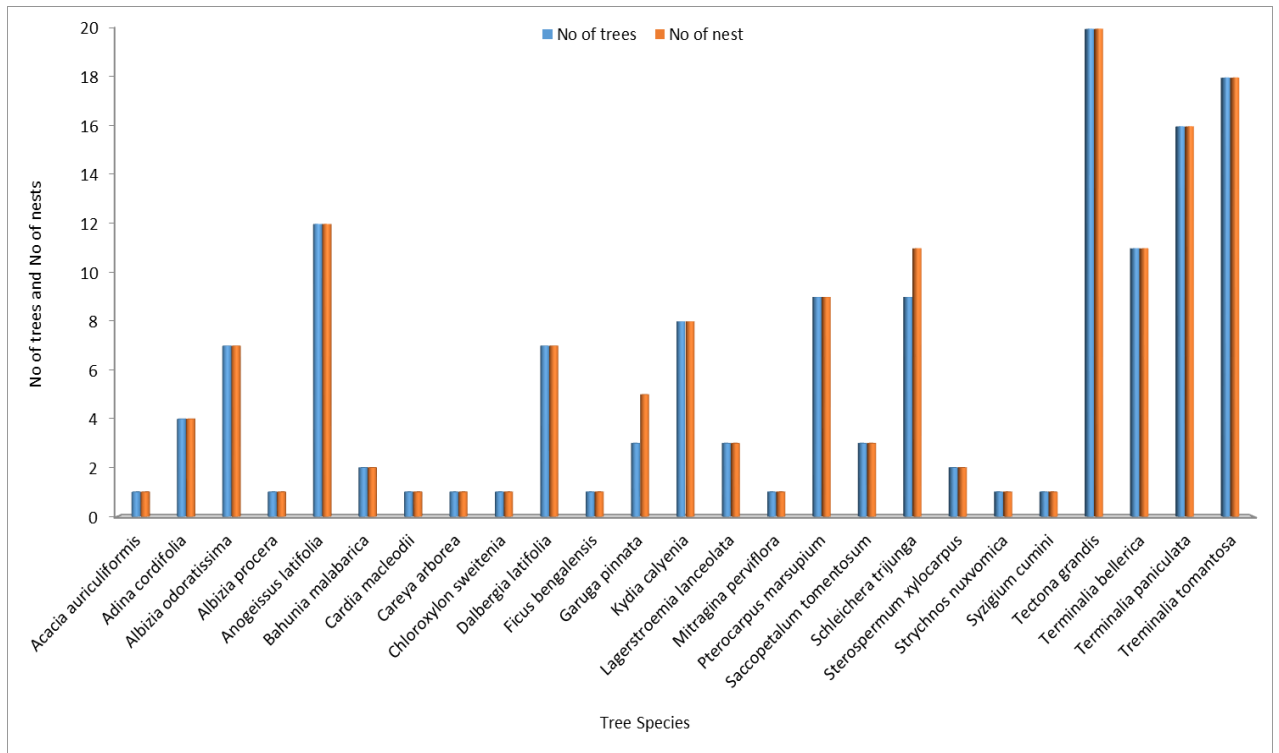


Fig. 6: Number of trees v/s number of dreys in Lakkinkoppa beat.



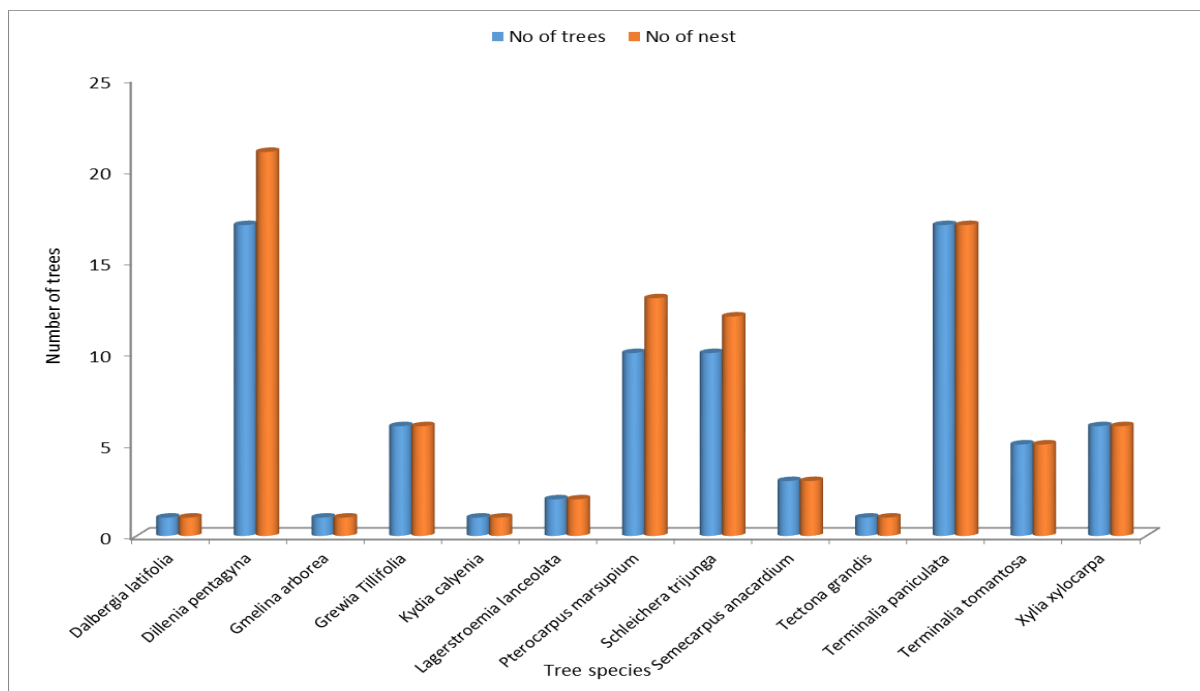


Fig. 7: Number of trees v/s number of dreys in Kydotlu beat.

## DISCUSSION

In the above study, the nest tree preferences of *Ratufa indica indica* were analyzed in the Umblebyle Range Forest of Bhadravathi division, Shimoga, Karnataka, which comprised four beats. Among the study beats, only three comprised forest cover: Umblebyle beat, Kydotlu beat, and Lakkinkoppa beat.

*Ratufa indica indica* used a large variety of tree species for nesting ( $n = 41$ ) in the study area, which is similar to previous records from Dalma wildlife sanctuary ( $n = 59$ ), Mudumalai Tiger Reserve ( $n = 19$ ), Karalpat Wildlife Sanctuary ( $n = 37$ ), Kuldiha Wildlife Sanctuary ( $n = 27$ ) and Sitanadi Wildlife Sanctuary ( $n = 30$ ). The animal was found to have a preference for some tree species. *Terminalia paniculata* (21.81%) was the most preferred tree species, followed by *Terminalia tomentosa* (11.68%), *Schleichera trijunga* (10.64%), *Pterocarpus marsupium* (8.83%) and *Tectona grandis* (7.27%). However, these trees were common to all three beats. The number of dreys varied with every beat. The animal constructed more dreys in forests around the human-disturbed area, i.e., Umblebyle and Lakkinkoppa beats, as they provided both shelter and easy access to food both from the forest and agricultural fields, least number of dreys were recorded in Kydotlu beat that had fairly undisturbed forest with an abundance of water

from Tunga backwaters indicating the dependency of animal on agricultural products. Similar nesting tree preference from Karalpat wildlife sanctuary showed preferences for *Terminalia alata* (11.03%) and *Anogeissus latifolia* (8.82%), Sitanadi wildlife sanctuary showed a preference for *Terminalia tomentosa* (14.73%), and *Schleichera oleosa* (13.39%), Mudumalai wildlife sanctuary showed a preference for *Terminalia arjuna* (10%), *Spondias mangifera* (9%) and *Syzygium cumini* (7%), Dalma Wildlife Sanctuary showed a preference for *Terminalia tomentosa* (23.97%) and *Anogeissus latifolia* (9.37%), Kuldiha Wildlife Sanctuary showed a preference for *Shorea robusta* (20%), *Schleichera oleosa* (17.5%) and *Terminalia tomentosa* (15%).

*Ratufa indica*, a top canopy-dwelling species, rarely visits the ground (Ramachandran 1992, Borges, 1989, Borges et al. 1992) and prefers tall trees with greater GBH, canopy contiguity, and height for construction of dreys (Basantha & Ajay 2015). In the study area, 83.89% of dreys were found in trees with a height of 11-20m. Similar preferences were observed in Karalpat Wildlife Sanctuary, with a preference for tall trees with a mean height of 11.08 ( $\pm 2.11$  SD) m, and Dalma Wildlife Sanctuary, with a preference for 12m to 21m, accommodating 86.15% of dreys. This preference provides easy access for movement in the home range and helps avoid and escape predators (Basantha & Ajay 2015, Mishra et al. 2011).

The animal preferred deciduous (78.04%) over evergreen (12.19%) and semi-evergreen (9.75%) trees. Similar preferences for deciduous trees were observed in Kuldiha Wildlife Sanctuary with deciduous (80%) and evergreen (20%) trees, in Dalma Wildlife Sanctuary with deciduous (83.26%), evergreen (13.02%) and semi-deciduous (3.72%) trees, in Karalpat Wildlife Sanctuary with dry deciduous (61.07%), semi-evergreen (30.15%) and moist deciduous (8.83%) trees, and in Sitanadi Wildlife Sanctuary with deciduous (77.68%) and evergreen (22.32%) trees.

Tree species selected for multiple nesting in the study area include *Dillenia pentagyna*, *Garuga pinnata*, *Pterocarpus marsupium*, *Schleichera trijunga*, *Tamrindus indica* and *Terminalia pinaculata*. Similar preferences were observed in the Dalma wildlife sanctuary, where multiple nests were found on *Lannea grandis*, *Anogeissus latifolia*, *Terminalia bellirica*, *Terminalia chebula*, *Terminalia tomentosa*, *Bombax ceiba*, *Dillenia pentagyna*, *Dillenia indica*, *Lagestroemia parviflora*, *Artocarpus lakoocha*, *Syzygium cumini* and *Sterculia urens*, Mudumali Tiger Reserve that included *Terminalia arjuna*, *Spondias Mangifera* and *Syzgium cumini* and Sitanadi Wildlife Sanctuary that included *Pterocarpus marsupium*, *Stereospermum chelonoides*, *Bridelia squamosal*, *Terminalia arjuna*, *Mangifera indica*, and *Schleichera oleosa*.

The nesting preference of *Ratufa indica* showed old and new nests along the transects (Mishra 2011). Among the dreys, 92.36% (375 number) were new, and 7.63% (31 number) were old, similar to observations from Dalma Wildlife Sanctuary, where 73.35 percent dreys were new, and 26.65 percent were old.

## CONCLUSION

*Ratufa indica indica*, a potential pollinator and a good indicator of forest health, becomes an important species to be conserved to conserve the forests as the importance of the animal in seed dispersal can not be ruled out. To reduce human-animal conflicts and the chances of animals being hunted outside the forest area, increasing the food source in the forest area is essential. Further, there is a need to create awareness among the people to reduce hunting. The animal population was good as we recorded 406 nests indicating the animal's survivability despite hunting and human disturbances. The study provides information on the nesting preference of the animal in Umbley Range Forest, which remains unexplored and can help conserve the animal in its habitat.

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