Research Article

Comparison of Tree Species Diversity and Usage by *Ratufa indica indica* in Umblebyle Range Forest, Bhadravathi Division, Shimoga, Karnataka, India

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ABSTRACT

Ratufa indica is an arboreal top canopy-dwelling species endemic to India. Tree species diversity of a forest plays an important role in the survival of arboreal species including *Ratufa indica*, hence the study was designed to analyze the tree species diversity of dry deciduous forests of the Umblebyle Range, Shimoga, Karnataka. The study was carried out using line transect methodology surveying 20 transects walking a total distance of 47.7 km of trees covering an area of 8350.89 ha. A total of 77 tree species belonging to 31 families were identified. Nest tree preferences were assessed through the observation of 406 and 455 dreys (nests) on 385 and 415 nesting trees belonging to 20 and 22 families in the year 2021 and 2022 respectively.

The animal was found to use the most abundant families and tree species 47 among 77 tree species were used for nesting, Fabaceae and *Terminalia paniculata* were the most preferred family and tree species, further deciduous trees were most preferred over others. The tree species diversity influences the nesting tree species diversity of the animal maintaining tree species diversity not only aids the conservation of animals in their habitat but also aids in the conservation of the forests.

Keywords: *Ratufa indica,* Oriental Giant Squirrels, Tree species diversity, Umblebyle Range forest, Dreys, Nesting.

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INTRODUCTION

Squirrels are members of Family Sciuridae including 5 Sub-Families 58 genera and 285 species, consisting of small to medium-sized rodents. *Ratufa indica*, a member of Sub-FamilyRatufinae includes 4 living species[1] classified morphologically and geographically namely *Ratufa affinis*,[2] *Ratufa bicolor*, *Ratufa macroura*[3] and *Ratufa indica*.[4] *Ratufa affinis* is found in East Malaysia, Indonesia, Brunei, and Thailand of Maritime Southeast Asia,[8] *Ratufa bicolor* is found fromMainland and Maritime Southeast Asia to East India,[5] *Ratufa macroura* is endemic to South Asia, distributed in Kerala and Tamil Nadu of India and Sri Lanka, *Ratufa indica* is endemic to India, distributed from Central to South India.[6]

Ratufa indica has 4 recognized sub-species *Ratufa indica indica*, *Ratufa indica centralis*,*Ratufa indica dealbata*, *Ratufa indica maxima. Ratufa indica indica* is a reddish brown/ maroon giant squirrel species endemic Western Ghats of Mumbai and Karnataka.[7-9] The animal is found to have a very significant role in shaping the ecosystem, being an arboreal upper canopy dwelling species the animal is extremely intolerant to habitat degradation and the tree species diversity plays an important role in the survival of the animal hence the study was designed to analyze the tree species diversity of Umblebyle Range Forest, Shimoga using line transect methodology and compare the usage by the animal.

Study Area

The Umblebyle range forest (Figure 1) is located within the geographic coordinates of latitudes 14° 0' 30" to 13°

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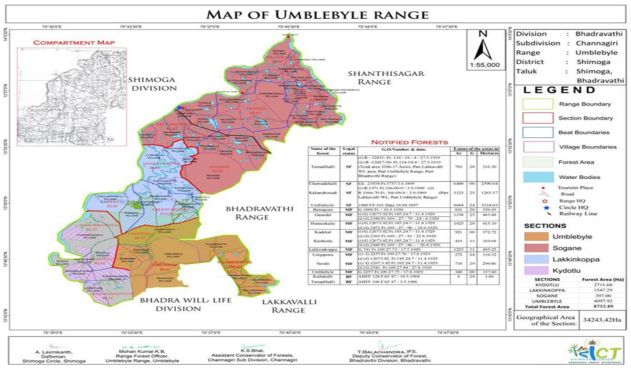

Figure 1: Map of Umblebyle Range Forest.

43' 0" N and longitudes 75° 30' 0" to 75° 47' 30" E in the south-western part of Bhadravathi division forest, Shimoga, Karnataka. The area enjoys a tropical climate throughout the year with annual average rainfall of 769.4 mm, and minimum and maximum temperatures of 20°C and 31°C respectively. The main watershed systems covering the area include the Tunga and Bhadra rivers, The topography of the location shows undulating hills and hillocks with a dry deciduous forest. The relief of the area varies between 500 and 1520 m above (Mean Sea Level) MSL. The area comprises 20 villages and four beats namely Umblebyle, Kydotlu, Lakkinkoppa and Sogane beats, among which three comprised of forest cover namely Umblebyle, Kydotlu and Lakkinkoppa beats. Prominent trees include *Terminalia paniculata, Terminalia tomentosa, Tectona grandis*.

MATERIALS AND METHODS

The survey was carried out using Line transect methodology.[10-12] The transects were laid using Arc Gis software ensuring they are spatially equidistant.

Nesting Behaviour

Nesting behaviour was analysed in the months of February to April of 2021 and 2022 by walking line transects in the morning from 06:00 am – 10:00 am as the animal is active during this period.[3] The number of nests and nesting tree species were documented considering different parameters like tree species, Height of tree, (Girth at Breast Height) GBH, number of nests, height of nest from the ground, age of the nest and (Global Positioning System) GPS location of the nest.[13]

Tree Species Diversity

For the Tree Species diversity quadrants of 20x20m were then laid at every 250m interval of line transect to analyse tree species diversity. These quadrants were then surveyed to collect information on individual tree species GPS location of trees, height of the trees etc. All the information collected will be noted down on the data sheets. The common names of the tree species were documented with the aid of the local personnel and their scientific names were ascertained from the books Forest Plants of the Nilgiris and Endemic woody plants of the Western Ghats.[14,15]

RESULTS

A total of 4892 trees were recorded in the study area, and 77 tree species belonging to 31 families were identified (Table 1). Among 31 Families (Figure 2) recorded 20 (Figure 3) and 18 (Figure 4) Families were used by the animal for nesting in 2021 and 2022 respectively. Fabaceae was not only the most abundant Family but also the most preferred Family by the animal, followed by Moraceae which was the second most abundant Family while the animal only used 2 tree species and Combretaceae was the third most abundant and second most preferred family, only one among 4 tree species of Family Bignoniaceae and 3 tree species of Family Rutaceae and 7 Families of 17 Families including 1 tree species each was used by the animal for nesting.

Among 77 tree species (Figure 5) recorded in the study area 41 (Figure 6) and 36 (Figure 7) tree species were used by the animal for nesting. *Terminalia paniculata* (21.81%, 2021 and 20.383%, 2022) was the most preferred tree species used by the animal for nesting, which was the second most abundant tree species recorded in the study area, followed by *Terminalia tomentosa* (11.68%, 2021 and 15.10%, 2022), while *Terminalia tomentosa* was found to be the most abundant tree species in the study area, followed by *Schleichera trijunga* (10.64%, 2021 and 8.87%, 2022), *Pterocarpus marsupium* (8.83%, 2021 and 8.39%, 2022) and *Tectona grandis* (7.27%, 2021 and 4.07%, 2022). Although a large number of tree species were used by the animal for nesting, the animal showed a preference for specific trees irrespective of their abundance of the trees in the study area, *Anogeissus latifolia*, *Xylia xylocarpa*, *Eucalyptus globulus*, *Dalbergia latifolia* in spite of their abundance were less preferred by the animal in comparison to *Schleichera trijunga*, *Pterocarpus marsupium* and *Tectona grandis* indicating the importance of these trees for the survival of the animal.

62 among 77 tree species were found to be Deciduous 10 tree species were found to be evergreen and 4 tree species were found to be semievergreen. The animal also showed to have preferences for Deciduous over Evergreen and Semi-Evergreen trees, among 44 nesting tree species recorded 34 trees were deciduous, 6 tree species were evergreen and 4 tree species were

Table 1: Tree species diversity of Umblebyle Range Forest.

Sl. No.	Family	Species	Tree type	Tree Height Avg	GBH Avg	No of trees	RA of trees (%)
1	Fabaceae	*Acacia auriculiformis*	E	17.38 ± 3.2	0.98 ± 0.42	57	1.16
2	Boraginaceae	*Cordia macleodii*	D	17.3 ± 1.94	1.06 ± 0.34	10	0.2
3	Bignoniaceae	*Kigelia africana*	D	17.5 ± 2.08	0.9 ± 0.24	4	0.08
4	Sapindaceae	*Sapindus laurifolius*	SE	18.8 ± 2.16	0.9 ± 0.22	5	0.102
5	Moraceae	*Ficus bengalensis*	SE	18.14 ± 2.82	1.07 ± 0.40	14	0.28
6	Apocynacae	*Wrightia tinctoria*	D	17.17 ± 4.16	0.99 ± 0.38	35	0.71
7	Moraceae	*Ficus religiosa*	D	18.5 ± 4.94	0.8	2	0.04
8	Rubiaceae	*Mitragina perviflora*	D	17.14 ± 2.73	1.24 ± 0.45	7	0.14
9	Fabaceae	*Albizia lebbeck*	D	19.5 ± 2.12	1.6 ± 0.56	2	0.04
10	Arecaceae	*Caryota urens*	E	19.6 ± 1.52	1.7 ± 0..51	3	0.06
11	Celastraceae	*Lophopetalum wighianum*	E	15	0.8	1	0.02
12	Fabaceae	*Porosopis cineraria*	D	16.25 ± 1.25	1.57 ± 0.99	3	0.06
13	Fabaceae	*Bahunia malabarica*	SE	15.8 ± 3.93	0.98 ± 0.42	30	0.61
14	Moraceae	*Ficus vierns*	D	15.8 ± 3.88	0.98 ± 0.24	8	0.16
15	Rutaceae	*Feronia elephantum*	D	15.5 ± 3.53	1.45 ± 0.77	2	0.04
16	Fabaceae	*Prosopis juliflora*	D	16.5 ± 2.12	1.5 ± 0.7	2	0.04
17	Malvaceae	*Kydia calycina*	D	17 ± 3.13	0.87 ± 0.19	21	0.43
18	Fabaceae	*Ougeinia dalbergioides*	D	16.6 ± 2.8	0.7 ± 0.07	5	0.102
19	Fabaceae	*Dalbergia latifolia*	D	17.2 ± 3.64	0.98 ± 0.41	210	4.1
20	Rutaceae	*Aegle marmelas*	D	17	2	1	0.02
21	Fabaceae	*Albizia odoratissima*	D	16.61 ± 3.08	0.85 ± 0.23	36	0.73
22	Fabaceae	*Albizia procera*	D	15.37 ± 2.06	0.83 ± 0.13	8	0.16
23	Malvaceae	*Bombax ceiba*	D	16.88 ± 3.4	0.95 ± 0.34	120	2.46
24	Cochlospermaceae	*Cochlospermums gossypium*	D	15.42 ± 3.9	1.17 ± 0.42	7	0.14
25	Cannabaceae	*Trema Orientalis*	D	15.75 ± 1.5	0.75 ± 0.12	4	0.08
26	Lythraceae	*Legastromia perviflora*	D	19.75 ± 2.87	0.92 ± 0.29	4	0.08
27	Rhamnaceae	*Ziziphus xylopyrus*	D	17.57 ± 3.97	0.94 ± 0.29	40	0.82
28	Malvaceae	*Grewia tillifolia*	D	17.25 ± 3.68	1.14 ± 1.28	32	0.65
29	Combretaceae	*Anogeissus latifolia*	D	17.3 ± 3.5	1.02 ± 0.44	372	7.62
30	Rubiaceae	*Hymenodicatyon excelsum*	D	16.18 ± 4.3	1.09 ± 0.46	27	0.55
31	Bignoniaceae	*Sterospermum xylocarpus*	D	16 ± 2.8	1.5 ± 0.7	2	0.04
32	Burseraceae	*Garuga pinnata*	D	16.67 ± 3.4	0.98 ± 0.32	58	1.18
33	Combretaceae	*Terminalia arjuna*	E	16.14 ± 3.1	0.73 ± 0.26	7	0.14
34	Fabaceae	*Pongamia pinnata*	D	16.05 ± 2.72	0.99 ± 0.4	17	0.34
35	Fabaceae	*Pterocarpus marsupium*	D	17.09 ± 3.5	0.97 ± 0.36	188	3.85
36	Combretaceae	*Terminalia paniculata*	D	17.51 ± 4.2	0.9 ± 0.43	548	11.22
37	Ebenaceae	*Diospyros monata*	D	17.19 ± 3.32	0.94 ± 0.24	71	1.45
38	Fabaceae	*Xylia xylocarpa*	D	16.96 ± 3.6	0.9 ± 0.32	313	6.41
39	Anacardiaceae	*Semecarpus anacardium*	D	17.67 ± 3.2	0.9 ± 0.22	41	0.84
40	Fabaceae	Cassia fiscula	D	15	1.2	1	0.02
41	Dilleniaceae	*Dillenia pentagyna*	D	17.12 ± 3.09	0.95 ± 0.36	103	2.11
42	Rubiaceae	*Calthium parvifolium*	D	16.9 ± 3.6	0.95 ± 0.41	126	2.58

Continued...

Table 1: Cont'd.

Sl. No.	Family	Species	Tree type	Tree Height Avg	GBH Avg	No of trees	RA of trees (%)
43	Moraceae	*Ficus tjakela*	D	18.5 ± 2.12	0.55 ± 0.21	2	0.04
44	Loganiaceae	*Strychnos nux-vomica*	D	15 ± 1.82	1.07 ± 0.42	4	0.08
45	Lecythidaceae	*Careya arborea*	D	16.8 ± 3	1 ± 0.35	86	1.76
46	Sapindaceae	*Schleichera trijunga*	SE	17.51 ± 4.23	1.06 ± 0.48	134	2.74
47	Apocynacae	*Holarrhena anticysenterica*	D	16.84 ± 2.73	0.84 ± 0.12	13	0.26
48	Fabaceae	*Acacia arabica*	D	16.75 ± 2.21	1.3 ± 0.82	4	0.08
49	Rutaceae	*Chloroxylon sweitenia*	D	16.78 ± 3.03	1 ± 0.42	99	2.02
50	Combretaceae	*Terminalia tomentosa*	D	17.21 ± 3.63	1 ± 0.45	617	12.64
51	Euphorbiaceae	*Mallotus philippinesis*	E	17.3 ± 2.3	0.9 ± 0.21	6	0.12
52	Fabaceae	*Butea monosperma*	D	17.69 ± 3.41	0.95 ± 0.39	81	1.66
53	Calophyllaceae	*Mesua ferrea*	E	17 ± 3.6	0.8	3	0.06
54	Lecythidaceae	*Couroupita guianensis*	D	20.3 ± 1.52	1.36 ± 0.56	3	0.06
55	Lythraceae	*Lagerstroemia lanceolata*	D	16.35 ± 3.58	0.95 ± 0.43	101	2.07
56	Lamiaceae	*Vitex altissima*	D	18.15 ± 4.2	1.12 ± 0.37	20	0.41
57	Phyllanthaceae	*Phyllanthus emblica*	D	17.43 ± 4.05	1.22 ± 0.58	37	0.75
58	Mythraceae	*Syzigium cumini*	E	16.36 ± 3.26	1.04 ± 0.29	11	0.22
59	Mythraceae	*Eucalyptus globulus*	E	16.96 ± 3.54	1.08 ± 0.49	224	4.59
60	Fabaceae	*Hardwickia binata*	D	15 ± 2.64	0.83 ± 0.15	3	0.06
61	Fabaceae	*Dalbergia paniculata*	D	16.21 ± 2.81	0.82 ± 0.21	21	0.43
62	Bignoniaceae	*Sterospermum sauveolens*	D	17.5 ± 0.57	1.25 ± 0.56	4	0.08
63	Fabaceae	*Cassia siamea*	E	17.2 ± 4.59	1.11 ± 0.59	27	0.55
64	Lamiaceae	*Gmelina arborea*	D	15.2 ± 1.64	0.94 ± 0.32	5	0.102
65	Proteaceae	*Grevillea robusta*	D	16.2 ± 3.56	1.08 ± 0.31	5	0.102
66	Malvaceae	*Holoptera integrifolia*	D	17.3 ± 3.51	0.73 ± 0.05	3	0.06
67	Combretaceae	*Terminalia bellerica*	SE	17.04 ± 3.65	0.97± 0.44	44	0.9
68	Lamiaceae	*Tectona grandis*	D	16.95 ± 4.3	1.01 ± 0.64	526	10.78
69	Moraceae	*Ficus racemosa*	D	17.56 ± 2.89	0.67 ± 0.18	8	0.16
70	Ebenaceae	*Diospyros melanoxylon*	D	16.77 ± 3.9	0.97 ± 0.39	77	1.57
71	Annonaceae	*Saccopetalum tomentosum*	D	17.15 ± 3.23	0.94 ± 0.33	20	0.41
72	Bignoniaceae	*Spathodea campanulata*	D	18.4 ± 3.2	1.34 ± 0.68	5	0.102
73	Cornaceae	*Alangium salbifolium*	D	18 ± 2.9	1.37 ± 1.08	4	0.08
74	Rubiaceae	*Adina cordifolia*	D	16.87 ± 3.85	1.11 ± 0.6	118	2.4
75	Sapotaceae	*Bassia latifolia*	D	17.5 ± 3.4	0.86 ± 0.1	16	0.32
76	Moraceae	*Ficus tsiela*	D	19.12 ± 1.8	1 ± 0.35	8	0.16
77	Fabaceae	*Tamrindus indica*	E	22 ± 2.89	1.48 ± 0.73	6	0.12

Semi-Evergreen. Tree species that showed multiple nesting include *Dillenia pentagyna, Garuga pinnata*, *Pterocarpus marsupium*, *Schleichera trijunga, Tamrindus indica* and *Terminalia pinaculata.*

Among 77 tree species recorded Umblebyle beat was found to have the highest tree species diversity which included 57 tree species, 28 and 24 tree species of which were used by the animal to construct dreys in the years 2021 and 2022 respectively, followed by Lakkinkoppa beat that included 55 tree species, 24 tree species of which were used by the animal to construct dreys in the year 2021 and 2022 respectively and Kydotlu beat that included 41 tree species, 13 and 12 tree species of which were used by the animal to construct dreys in the year 2021 and 2022 respectively. 49.12% and 42.1%, 43.63%, 31.7 and 29.2% of trees were used for nesting by *Ratufa*

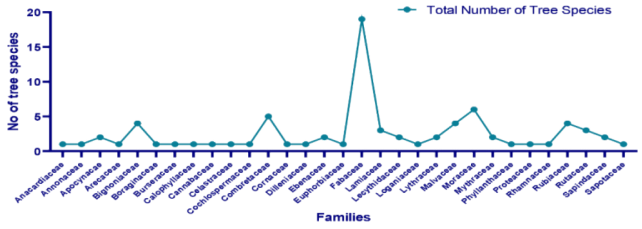

Figure 2: Diversity of Family in Umblebyle Range Forest 2021.

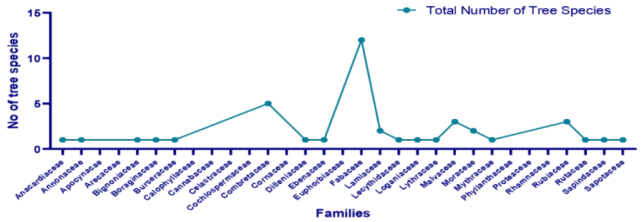

Figure 3: Family usage by *Ratufa indica indica* in 2021.

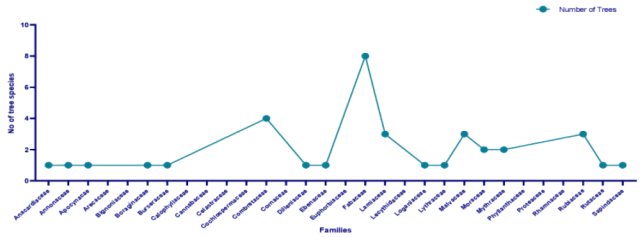

Figure 4: Family usage by *Ratufa indica indica* in 2022.

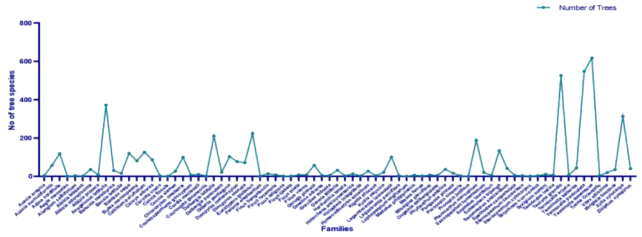

Figure 5: Tree species diversity of Umblebyle Range Forest.

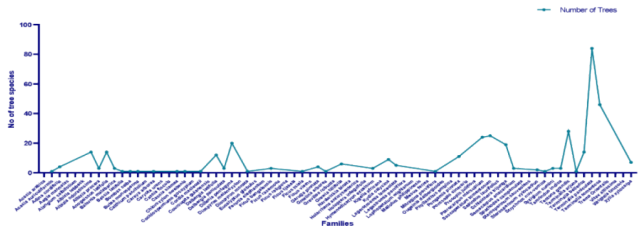

Figure 6: Nesting tree species diversity of Umblebyle Range Forest 2021.

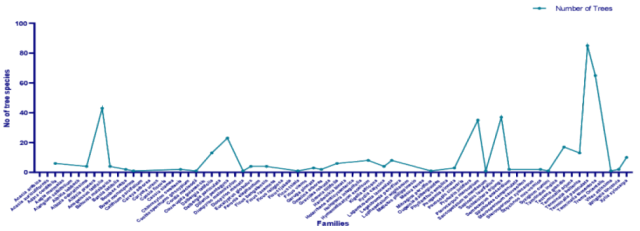

Figure 7: Nesting tree species diversity of Umblebyle Range Forest 2022.

indica indica in Umblebyle beat, Lakkinkoppa beat and Kydotlu beat in the year 2021 and 2022 respectively.

28 tree species were common to all three beats namely *Albizia odoratissima*, *Anogeissus latifolia*, *Bahunia malabarica*, *Bassia latifolia*, *Bombax ceiba*, *Butea monosperma*, *Calthium parvifolium*, *Careya arborea*, *Cassia siamea*, *Dalbergia latifolia*, *Dillenia pentagyna*, *Diospyros monata*, *Eucalyptus globulus*, *Ficus bengalensis*, *Garuga pinnata*, *Kydia calycina*, *Lagerstroemia lanceolata*, *Phyllanthus emblica*, *Pterocarpus marsupium*, *Schleichera trijunga Semecarpus anacardium*, *Syzigium cumini*, *Tectona grandis*, *Terminalia bellerica*, *Terminalia paniculata*, *Terminalia tomentosa*, *Wrightia tinctoria* and *Ziziphus xylopyrus*.

11 tree species were common to Umblebyle and Lakkinkoppa beats namely *Acacia auriculiformis*, *Adina cordifolia*, *Chloroxylon swietenia*, *Cochlospermums campanulata*, *Diospyros melanoxylon*, *Hardwickia binate*, *Hymenodicatyon excelsum*, *Mesua ferrea*, *Pongamia pinnata*, *Saccopetalum tomentosum* and *Vitex altissima*. 6 tree species were common to Umblebyle and Kydotlu beats namely *Dalbergia paniculata*, *Ficus vierns*, *Gmelina* arborea, Kigelia *africana*, *Sapindus laurifolius* and *Xylia xylocarpa*.

10 tree species were endemic to Umblebyle beat namely *Acacia arabica*, *Aegle marmelas*, *Alangium salbifolium*, *Couroupita guianensis*, *Holarrhena anticysenterica*, *Holoptera integrifolia*, *Legastromia parviflora*, *Ougeinia dalbergioides*, *Spathodea campanulata* and *Terminalia arjuna*. 14 tree species were endemic to Lakkinkoppa beat namely *Albizia lebbeck*, *Albizia procera*, *Caryota urens*, *Cordia macleodii*, *Feronia elephantum*, *Ficus racemosa*, *Grevillea robusta*, *Lophopetalum wighianum*, *Mitragina perviflora*, *Porosopis cineraria*, *Prosopis juliflora*, *Sterospermum sauveolens*, *Sterospermum xylocarpus* and *Strychnos nux-vomica* and 6 tree species were endemic to Kydotlu beat namely *Cassia fiscula*, *Ficus religiosa*, *Grewia tillifolia*, *Holarrhena anticysenterica*, *Mallotus philippinesis* and *Trema Orientalis*.

In all three beats the average tree height was estimated to be 17.09 (± 3.54) m, the average nesting tree height was estimated to be 16.18 (± 3.430) m and 18.05 (± 3.485) m and The average nest height was estimated to be 14.73 (± 3.311) m and 16.25 (± 3.25) m in the year 2021 and 2022 respectively. The most abundant tree height was 11-20m which was the most preferred height that comprised 83.84% of trees, 87.53% and 76.97% of nesting trees, 83.89% and 88.48% of nests in the years 2021 and 2022 respectively.

The average GBH was estimated to be 1 (± 0.42) m, and the average nesting tree GBH was estimated to be 0.912 (± 0.373) m and 1 (± 0.44) m in the years 2021 and 2022 respectively. The most abundant GBH was 0.6-1.5m which was the most preferred GBH that comprised 87.82% of the trees, 87.27% and 87.29% of nesting trees in the year 2021 and 2022 respectively

DISCUSSION

The animal not only showed to have preferences for tree species, height, GBH etc. but also showed to have preferences for Families Fabaceae was the most preferred Family which was also the most abundant family followed by Family Combretaceae, Malvaceae, Rubiaceae, and Lamiaceae, Moraceae, Mythraceae, Moraceae being second most abundant family was not the most preferred family, and only 7 among 17 families that included 1 tree species were chosen for nesting indicating preference of the animal for families with more no of tree species.

Ratufa indica indica used a large variety of tree species for nesting, which is similar to observations from Dalma Wildlife Sanctuary (n = 59),[16] Mudumalai Tiger Reserve (n = 19),[17] Karalpat Wildlife Sanctuary (n = 37), Kuldiha Wildlife Sanctuary (n = 27)[18] and Sitanadi wildlife sanctuary (n = 30).[19] Tree species diversity of a forest plays a very important role in the survival of the animal as the tree species diversity was found to greatly influence the nesting tree species diversity of the animal. Umblebyle with the highest tree species diversity was found to have 49.12% and 42.1% of tree species selected for nesting, followed by Lakkinkoppa beat where 43.63% of tree species were used for nesting while Kydotlu beat was found to have the lowest tree species diversity where the animal only used 31.7% and 29.2% of tree species for nesting. There was a significant reduction in the nesting tree species diversity of the animal with the reduction of tree species diversity. Hence there is a need to maintain tree species diversity to maintain nesting tree species diversity to create a suitable habitat for the animal.

The preference of animals towards specific trees irrespective of their abundance in the study area indicated the importance of these trees for the survival of the animals. The animal was found to have preferences for some tree species over others, this preference was not only recorded in the study area but also previous studies from wildlife sanctuaries like Karalpat, Sitanadi, Mudumalai, Dalma and Kuldiha. In the study area, the animal showed preferences for *Terminalia paniculata*, *Terminalia tomentosa, Schleichera trijunga*, *Pterocarpus marsupium and Tectona grandis* over other tree species which were available in all three beats. Although these trees were common to all three beats the number of dreys in every beat varied, 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 clearly indicating the dependency of animal on agricultural products. This adaptation of the animal highlights the need for increasing feeding and nesting trees of the animal in the forest area.

The preference of the animal for Deciduous trees over Evergreen and Semi-Evergreen trees was not only observed in the study area but also observed in previous studies from Kuldiha, Dalma, Karalpat and Sitanadi wildlife sanctuaries where the animal constructed 80%, 83.26%, 61.07% and 77.68% of nests in Deciduous trees.

Multiple nesting was only observed in specific trees, this observation was seen in the study area and previous observations from wildlife sanctuaries like Dalma, Mudumalai and Sitanadi. In the study area, Multiple nesting was found in tree species like *Dillenia pentagyna, Garuga pinnata*, *Pterocarpus marsupium*, *Schleichera trijunga, Tamrindus indica* and *Terminalia pinaculata*. Except for *Tamrindus indica,* all the other trees were common to all 3 beats which was absent in Kydotlu beat.

The tree species diversity varied in every beat, the nesting tree species diversity was found to increase with tree species diversity. 49.12% and 42.1% of tree species were used by the animal for nesting in Umblebyle beat which was found to have the highest tree species diversity which was similar to Lakkinkoppa beat where 43.63% of trees were used for nesting, while only 31.7% and 29.2% of Kydotlu beat which had lowest tree species diversity indicating the importance of tree species diversity.

Ratufa indica is a top canopy dwelling arboreal squirrel species that rarely visits the ground[4,13] preferring tall trees with greater GBH and canopy contiguity for the construction of dreys[3] The average tree height and GBH in the study area were estimated to be 17.09 (± 3.54) m and 1 (± 0.42) m, and the average nesting tree height and GBH was estimated to be 16.18 (± 3.430) m, 18.05 (± 3.485) m and 0.912 (± 0.373) m, 1 (± 0.44) m which was around the average tree height and GBH of the study area. In the Study area 83.84% of trees, 87.53% and 76.97% of nesting trees, 83.89% and 88.48% of nests ranged within height 11-20 m and

87.82% of the trees, 87.27% and 87.29% of nesting trees ranged within the GBH of 0.6-1.5 m, this preference not only helps in escaping and avoiding predators but also provides easy access for the movement in the home range.[3,9]

CONCLUSION

Tree species diversity of a forest plays a prominent role in the survival of arboreal species including *Ratufa indica* the study helped us to understand tree species diversity of the Umblebyle range forest and usage by *Ratufa indica indica*. The nesting tree species diversity was found to increase with the tree species diversity of the forest Umblebyle and Lakkinkoppa beats were found to have the highest tree species and nesting tree species diversity while Kydotlu beat had lower tree species and nesting tree species diversity. Further, the animal had preferences for certain families and tree species over others; *Fabaceae* and *Terminalia paniculata* were the most preferred family and tree species, and maintaining the population of these tree species would help the survival of the animal in its habitat.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVATIONS

MSL: Mean Sea Level; **GBH:** Girth at Breast Height; **GPS:** Global Positioning System.

SUMMARY

Umblebyle Range Forest is a tropical dry deciduous forest located in the southwestern part of Shimoga, Karnataka sharing its boundary with Bhadra Tiger Reserve, the area is subjected to anthropogenic pressure from the villages surrounding it causing habitat degradation. The present study determines the habitat structure of Umblebyle Range Forest and usage by the animal which was carried out using line transect methodology. *Ratufa indica indica* being a potential pollinator helps in maintaining tree species diversity in the forest via seed dispersal also the animal being a great indicator of the health of the forest helps determine the current situation of the forest, understanding the ecology of the animal not only helps us to conserve the animal but also conserve the forest 49.12% and 42.1%, 43.63%, 31.7 and 29.2% of trees were used for nesting by *Ratufa indica indica* in Umblebyle beat, Lakkinkoppa beat and Kydotlu beat in the year 2021 and 2022 respectively. Kydotlu had the least nesting and tree species diversity among all the 3 beats, maintaining tree species diversity not only conserves the forest but also aids in conserving animals in its habitat.

Data and materials availability

All data associated with this study are present in the paper.

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