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Journal of Threatened Taxa

10.11609/jott.2023.15.10.23931-24150

www.threatenedtaxa.org

26 October 2023 (Online & Print)

15(10): 23931-24150

ISSN 0974-7907 (Online)

ISSN 0974-7893 (Print)



Open Access





ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

Publisher
Wildlife Information Liaison Development Society
www.wild.zooreach.org

Host
Zoo Outreach Organization
www.zooreach.org

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Cover: Orange Oakleaf *Kallima inachus* with colour pencils and watercolor wash by Elakshi Mahika Molur adapted from a workshop by Lenin Raj.

INTRODUCTION

Ficus is one of the largest genera of woody species in the tropics and subtropics (Janzen 1979; Berg 1989; Harrison 2005) with approximately 750 species occurring globally (Berg 2005). India has 115 *Ficus* taxa belonging to 89 species and 26 intra-specific taxa (Chaudhary et al. 2012); 58 species have been reported from Arunachal Pradesh alone (Buragohain 2014). Tropical forests are a rich source of food for animals dependent on fruit (Fleming et al. 1987; Corlett 1998), where *Ficus* is identified as a vital 'keystone' food resource that attracts tropical frugivorous animals (Kinnaird et al. 1996; Kannan & James 1999; Kissling et al. 2007). Keystone plants play a significant role in setting the carrying capacity of the frugivore community and in the tropics, the diversity and abundance of *Ficus* (figs) correlate with the diversity or richness of frugivores (Goodman et al. 1997). *Ficus* sustain diverse organisms owing to dense foliage and moisture retention capacity that provides an ideal habitat in terms of nesting, roosting, and perching grounds for vertebrate species (Vanitharani 2006). Although figs are considered keystone species, this concept usually signifies the whole *Ficus* community rather than a single species (Kinnaird et al. 1999). The existence of different *Ficus* dispersal guilds implies that fig preference of frugivores is influenced by chemical, and morphological variables such as size, colour, display mechanism and habitat characteristics such as forested, disturbed, and urban. (Sanitjan & Chen 2009; Lok et al. 2013; Daru et al. 2015). Different species of figs differ in their nutrient content nevertheless; a single species is insufficient to provide adequate nutrients to the species that depend on it (Wendeln et al. 2000). Non-bird dispersal *Ficus* often display their figs in places where it is not convenient for the birds (Lambert 1989a; Shanahan & Crompton 2001). These traits help *Ficus* species to attract discrete frugivore species which, in return guide frugivores while selecting suitable fruits. A global review of figs and vertebrates revealed that 1,274 bird and mammal species in 523 genera and 92 families are known to eat figs apart from the small number and fish and reptiles (Shanahan et al. 2001).

Studies on fig dependency on vertebrates in India particularly in northeastern India are scanty where the *Ficus* diversity is higher and usually such studies are species-specific (Datta & Rawat 2008; Krishna et al. 2014). Therefore, the present study was planned to investigate the vertebrate assemblages, inter-species differences among the fruiting *Ficus* and non-fig species and *Ficus* preference of vertebrates over a period of 60 days to

understand how *Ficus* species form the focal points for vertebrate assemblages in Pakke Wildlife Sanctuary of Arunachal Pradesh, India. Thus, providing insights into vertebrates that are dependent on figs in this region.

METHODS

Study Site

This study was conducted in Pakke Wildlife Sanctuary (PWS) 27.430278° N to 93.4025° E and 28.369167° N to 94.360833° E located in the Pakke Kesang district, Arunachal Pradesh. It is one of the best-managed protected areas of the state among the 13 protected areas and is famous for the two major flagship species, viz., hornbills and tiger. PWS shares its boundary with Nameri Tiger Reserve, Doimara Reserve Forest, Papum Reserve Forest, Tenga Reserve Forest, and Sessa Orchid Sanctuary and it is surrounded by Pakke River in the east Kameng River in the west and north. The rugged and hilly terrain encompasses elevational diversity, ranging 150–2,000 m. The forest falls under the classification of Assam Valley tropical semi-evergreen forest 2B/C1 according to Champion & Seth (1969). It has a tropical and subtropical climate where October to February is the coldest month (Birand & Power 2004), and May and June are the hottest. Park receives rainfall from south-west monsoon (May–September) and north-east monsoon (November–April). The average annual rainfall ranges 2,086.9–2,972.7 mm (humid subtropical region-cold humid regions) and the average mean maximum and minimum temperatures are 29.5° C and 17.7° C in the humid subtropical region and 21.4° C and 2.4° C in the cold humid region (Buragohain 2014). The floristic and climatic conditions provide rich faunal diversity in the sanctuary by documenting 60 species of mammals, 282 species of birds (Kumar 2014) and home to around 340 species of butterflies (Sondhi & Kunte 2014). The area holds four species of hornbill and is stated to be one of the best places for frequent sightings of hornbill species in the state (Datta 2001).

There are 19 villages located in the eastern periphery of the sanctuary and the population is dominated by Nyishi; a major ethnic tribe of the state (Vishwakarma et al. 2021). Their livelihood involves the collection of non-timber forest produce, hunting and fishing, shifting agriculture and cultivation of rice (Datta et al. 2008; Hui et al. 2012), maize and millets. The West Bank area (26.938° N, 92.911° E) with an elevation of 150–600 m (Datta & Rawat 2008) of the sanctuary was selected to document the assemblage of vertebrate species on

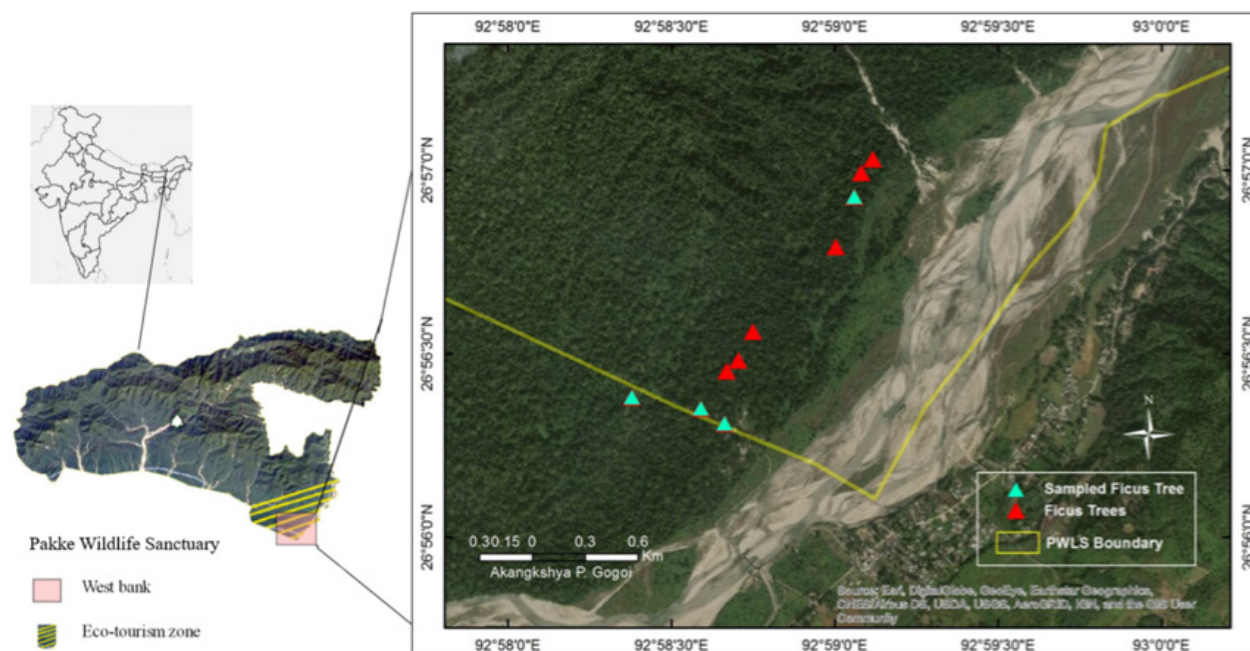


Image 1. Map of west bank showing locations of *Ficus* trees chosen for documenting the vertebrate species, Pakke Wildlife Sanctuary, Arunachal Pradesh.

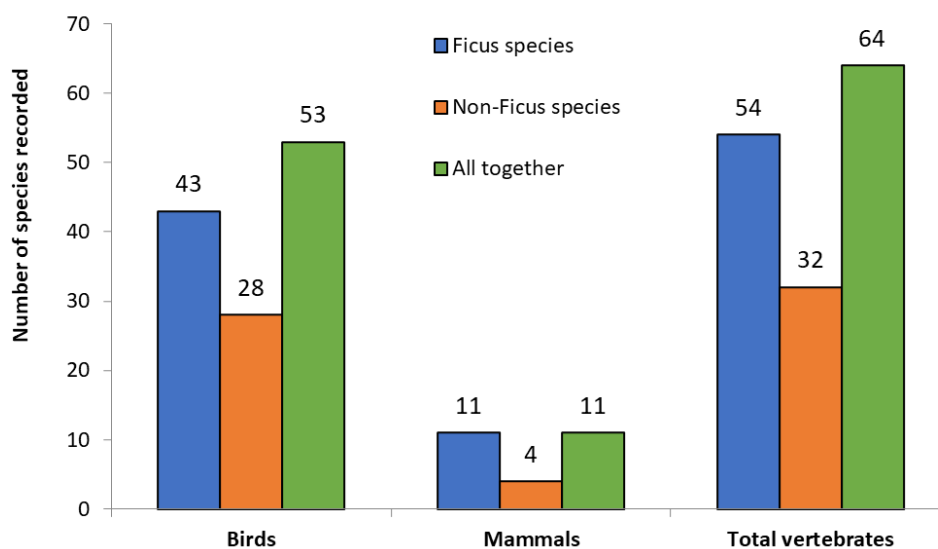


Figure 1. Vertebrate diversity was recorded at the focal *Ficus* and non-ficus plants in the west bank, Pakke Wildlife Sanctuary.

fruiting *Ficus* species found in the area, as it is located approximately 3 km away from the office of Pakke headquarter (Seijosa) and reachable site for the tourist (Figure 1).

Method and materials

During the study period, the existing nature trail in the study area was first surveyed to locate fruiting *Ficus* species and fruiting and flowering non-ficus

plants. Secondly, bird surveys were conducted on the nature trail twice a week (16 days) from 0600–1000 h and 1300–1600 h to record the bird species of the site usually when the vertebrate fauna was active. Four *Ficus* species with over 40% ripe fruits found in the nature trail were chosen and tagged as suitable focal *Ficus* trees to document the vertebrate assemblage. *Ficus geniculata* and *Ficus altissima* are hemi-epiphytic axillary (inflorescence present in the leaf axis) plants,

while *Ficus variegata* is a cauliflorous (inflorescence present in the trunk) tree. Fruiting and flowering non-figus plants present within a 10-m radius of the focal *Ficus* species were also documented to compare the vertebrate assemblage with *Ficus* plants. *Ficus* species were distinguished by referencing the taxonomic framework established by Buragohain (2014). Avian identification was facilitated through the utilization of established field guides authored by Grimmett et al. (2016), while for mammalian species classification, the field guide 'Mammals of India' by Menon (2014) served as a point of reference.

Scan sampling for vertebrate species, including both mammal and bird assemblages on focal trees and non-figus plants, was conducted between February and April 2019. The survey encompassed both direct sightings and indications of vertebrate presence. Over the 60-day (89-h) study period, selected focal *Ficus* species were visited biweekly, with observations carried out twice a week during the time intervals of 0600–0900 h and 1330–1630 h. A total of 44 scan sample episodes were performed, each averaging 3-h per scan, and yielding an average of two samples per day. During each scan of focal species, the species name, the total count of visiting individuals, and the overall time spent by the visiting vertebrate species were meticulously documented. In the case of non-figus plants, the name of the visiting vertebrate species and the total count of species encountered during each scan were recorded.

In this study, the vertebrate species data associated with each focal *Ficus* species were compared during scanning sessions with the data collected from the neighboring non-figus fruiting and flowering plants. The recorded vertebrate species counts for both focal *Ficus* and non-figus species were categorized into four rankings: 1 for counts between 0 and 5, 2 for counts between 6 and 11, 3 for counts between 12 and 17, and 4 for counts exceeding 18. This ranking system aimed to quantify the variation in vertebrate assemblages between *Ficus* and non-figus plants, with statistical analysis performed using the Mann-Whitney U test. Furthermore, the spatial distribution of species was analyzed by considering the number of vertebrate species visiting each focal species, employing the variance-to-mean ratio (VMR). The VMR, a tool for discerning spatial object distribution, indicated random distribution at VMR = 1.0, clump distribution at VMR > 1.0, and uniform distribution at VMR < 1.0, as per Datta & Rawatt (2008). Additionally, to evaluate the similarity of vertebrate species among different *Ficus* species, the Jaccard similarity index was computed, shedding light

on species likeness within the focal *Ficus* species' group.

Vertebrates directly observed feeding on figs were categorized into three groups: frugivorous birds (including Bulbuls, Barbets, Pigeons, Hornbills, Mynas, Orioles, and Asian fairy bluebirds) following Naniwadekar et al. (2019), opportunistic feeders of figs (occasionally consuming figs), and mammals (detailed in Appendix 2). The preference of vertebrate species for specific *Ficus* species was determined using data on the number of individuals, total time spent, and visit frequency, applying the formula established by Ragusa-Netto (2002). *Ficus variegata* was excluded from *Ficus* preference analysis due to its infrequent encounters throughout the sampling period. Let, $P_x = \{\text{Mean individual/scan} * \text{Mean visiting time duration of species/scan} * \text{visiting frequency (no. of time a species visited a focal tree throughout the survey)}\}$, P = Presence value of a vertebrate species in a focal *Ficus* species, x = *Ficus* species.

$TP_x = \text{Sum of } (P_x) \text{ of all vertebrate species assembled in the focal } Ficus \text{ species}$

$\text{Tree preference (percentage)} = P_x / TP_x * 100$

RESULTS

A total of 15 individuals of five *Ficus* species, viz., *Ficus nervosa* (1), *Ficus drupacea* (7), *Ficus geniculata* (3), *Ficus altissima* (2), & *Ficus variegata* (2) and 13 species ($n = 41$) of non-figus fruiting and flowering plants representing 10 families; *Canarium resiniferum*, *Duabanga grandiflora*, *Sterculia villosa*, *Sterculia colorata*, *Tetrameles nudiflora*, *Shorea robusta*, *Dysoxylum binectariferum*, *Artocarpus chaplasha*, *Polyalthia simiarum*, *Chisocheton paniculatus*, *Aglaia spectabilis*, *Phlogacanthus thyrsoformis* (shrub), *Dilenia indica* (Appendix 3) was recorded. *Ficus drupacea*, *Ficus geniculata* and *Ficus altissima* are hemi-epiphytic axillary (inflorescence present in the leaf axis) plants while *Ficus variegata* is cauliflorous (inflorescence present in the trunk) tree.

Vertebrate diversity in the West bank area of PWS

During the study, a total of 64 vertebrate species within four focal *Ficus* species and the surrounding non-figus fruiting and flowering plants were identified. Among these, there were 53 bird species belonging to 29 families and 43 genera, as well as 11 mammal species from seven families and 10 genera (Figure 2). It's important to note that across the entire study duration, the nature trail recorded a comprehensive total of 98

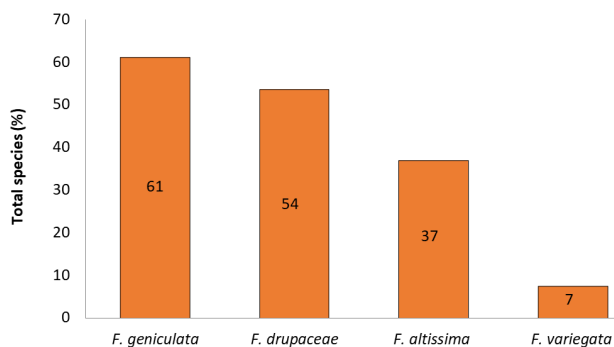


Figure 2. Vertebrate species composition at focal *Ficus* trees in the west bank, Pakke Wildlife Sanctuary out of all the species recorded.

bird species representing 39 families and 76 genera, and this information is provided in Appendix 1.

Vertebrate assemblage

Recorded were 43 species of birds (21 families, 34 genera) and 11 species of mammals (7 families, 10 genera) in focal *Ficus* species, namely, *variegata*, *drupacea*, *altissima*, and *variegata*. Additionally, 28 species of birds (21 families, 23 genera) and four species of mammals (3 families, 4 genera) were found in fruiting

and flowering non-figs plants within a 10 m radius of the focal *Ficus* species (Figure 2). The highest vertebrate assemblage was observed in *Ficus variegata*, accounting for 61% (29 bird species, 4 mammal species), followed by *Ficus drupacea* at 54% (22 bird species, 7 mammal species), *Ficus altissima* at 37% (19 bird species, 1 mammal species). The lowest vertebrate assemblage was recorded in *Ficus variegata*, constituting 7% (3 bird species, 1 mammal species) (Figure 3). The most prevalent vertebrate species within *Ficus* were green pigeons (4 species, 70.2 individuals/scan), followed by mynas (1 species, 32.3 individuals/scan), bulbuls (6 species, 28.3 individuals/scan), hornbills (3 species, 13.4 individuals/scan), Asian fairy bluebirds (1 species, 12.4 individuals/scan), along with other bird species (19 species, 9.8 individuals/scan), mammals (11 species, 7.3 individuals/scan), opportunists (4 species, 7.1 individuals/scan), barbets (3 species, 5.2 individuals/scan), and orioles (2 species, 2.2 individuals/scan) (Figure 4).

Birds visited the *Ficus* species more frequently during the different times. The mean vertebrate assemblage (clockwise direction) in fig trees (21.5 ± 12.9), *Ficus geniculata* (11.3 ± 4.9), *Ficus drupacea* (7.3 ± 3.6), *Ficus*

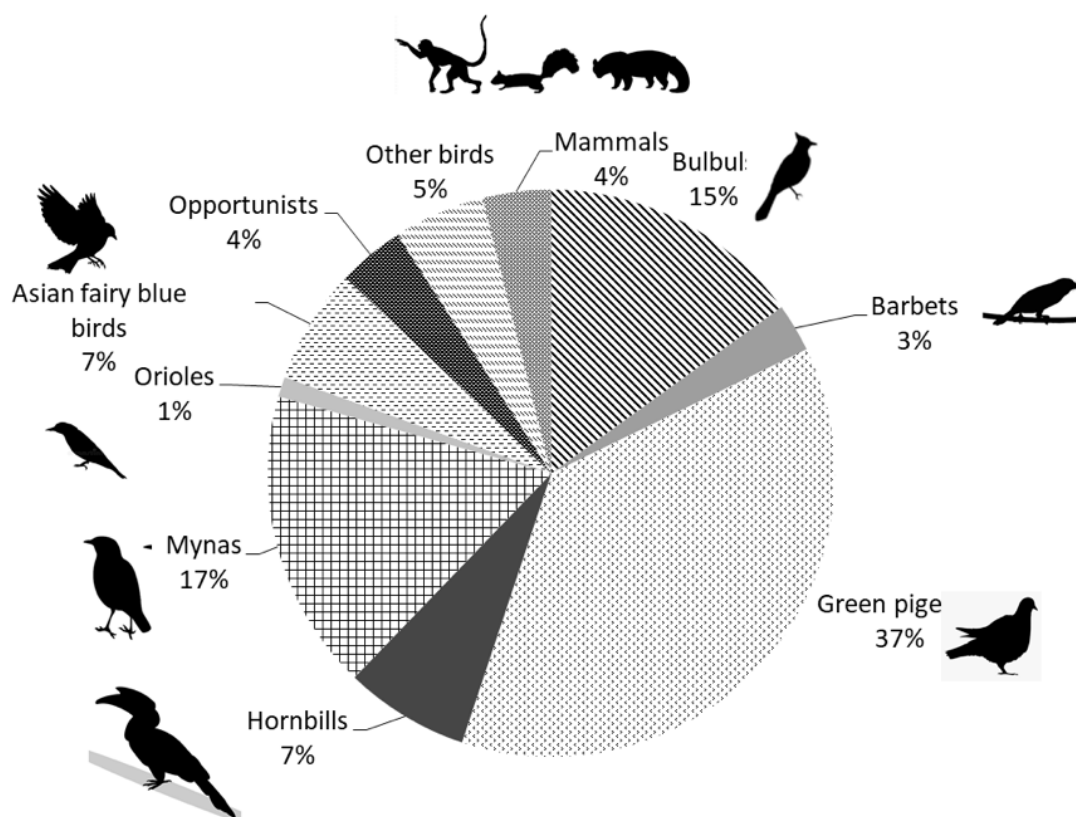


Figure 3. The abundance of different vertebrate taxa ($n = 54$) was observed in focal *Ficus* species during the study.

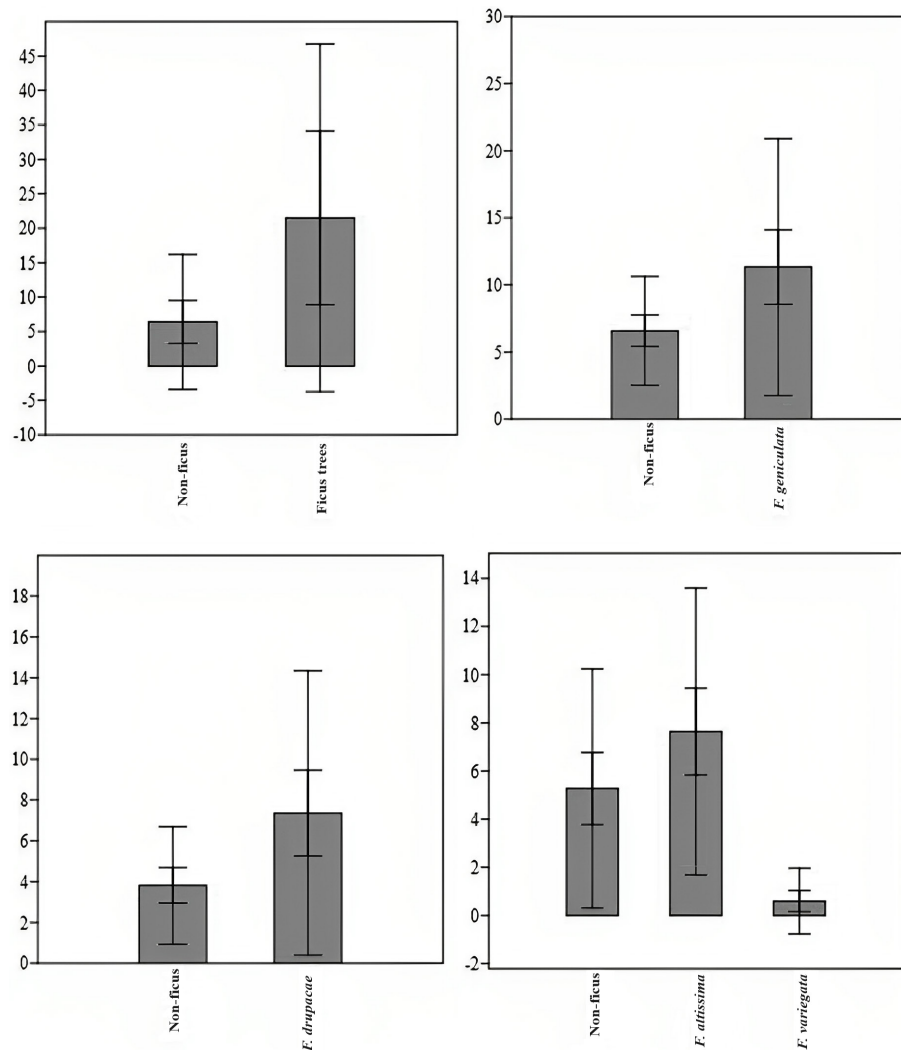


Figure 4. Mean vertebrate assemblage (clockwise direction) in *Ficus* trees (21.5 ± 12.9), *Ficus geniculata* (11.3 ± 4.9), *Ficus drupacea* (7.3 ± 3.6), *Ficus altissima* (7.6 ± 3), *Ficus variegata* (0.6 ± 0.7) and non-ficus fruiting and flowering trees (6.4 ± 5 , 6.9 ± 2.07 , 5.27 ± 2.53 , 3.82 ± 1.5 within 10-m radius).

altissima (7.6 ± 3), *Ficus variegata* (0.6 ± 0.7), and non-ficus fruiting & flowering trees (6.4 ± 5 , 6.9 ± 2.07 , 5.27 ± 2.53 , 3.82 ± 1.5 within 10 m radius) (Figure 5).

Comparison of vertebrate species between *Ficus* versus non-ficus plants

Both bird and mammal surveys in the study site recorded the maximum number of vertebrate species at focal *Ficus* at 44% and 84.4% respectively as compared to non-ficus plants at 29% and 50% (Figures 2 & 6). On the other hand, 32 vertebrate species in *Ficus* and 10 vertebrate species in non-ficus recorded during the scan sampling were unique or specifically confined themselves to either *Ficus* or non-ficus. While 34 vertebrate species were common between *Ficus* and non-ficus plants (Appendix 1 and 2), the number of

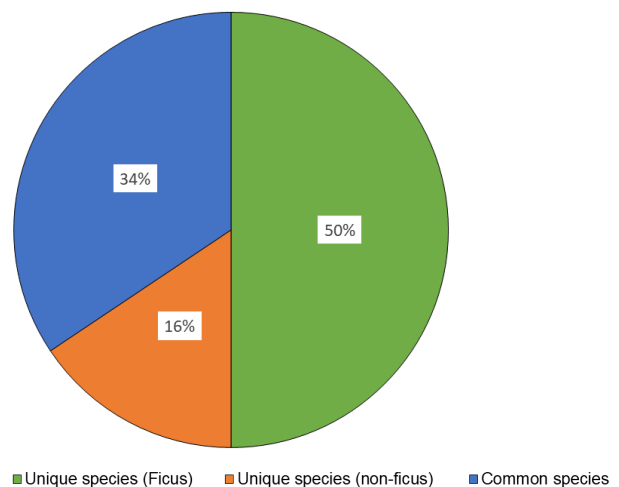


Figure 5. Composition of unique and common vertebrate species recorded in focal *Ficus* and fruiting and flowering non-ficus plants.

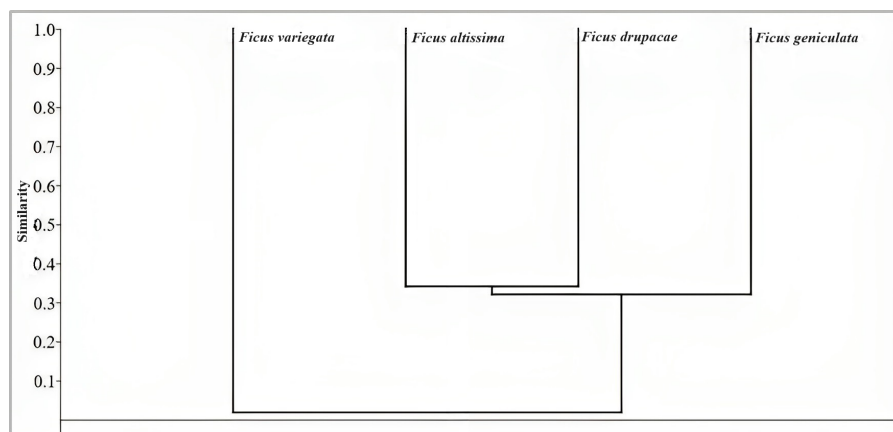


Figure 6. Dendrogram showing the similarity (Jaccard similarity) of vertebrate assemblages in *Ficus* species using cluster analysis.

vertebrate species assembled in *Ficus* per scan was significantly different from non-figs plants ($U = 830$, $z = 5.99$, $p = 0.0001$, critical value = 1.96). The average VMR for *Ficus* species is (1.5, Range 0.8–2.1) and for non-figs plants is (0.8, Range 0.2–2.9).

Ficus tree preference

Less than 35% of the vertebrate species were similar among *Ficus drupacea*, *Ficus variegata* and *Ficus altissima* and almost zero similarity was recorded between *Ficus variegata* and other focal *Ficus* species (Figure 7). *Ficus* tree preference (percent) of bulbuls, barbets, green pigeons, hornbills, mynas, orioles, Asian fairy bluebirds, opportunists and mammals in the west bank is analysed in (Table 1).

Vertebrate groups observed in the *Ficus* trees, mean number of individuals, visiting frequency, visiting duration in each tree per scan and preference of vertebrate groups towards *Ficus* tree (Table 2).

The vertebrate assemblages and the dominant species recorded in *Ficus* plants in Tropical regions across different time and habitat types were compared. Data was collected from the literature as mentioned in the parenthesis (Lambert 1989a; Shanahan 2000; Sanitjan & Chen 2009; Barua & Tamuly 2011; Lok et al. 2013; Daru et al. 2015). The different parameters like LD = low disturbance, D = disturbed, F = Forest, A = agricultural matrix, and U = urban. (*) = only bird diversity was recorded, (^) = Current study, Jan. = January, Sept. = September, Oct. = October (Table 3) was assessed.

DISCUSSION

This study provides information on distinct vertebrate assemblage in *Ficus* and non-figs plants. Large vertebrate assemblage recorded at *Ficus drupacea*, *Ficus geniculata*, and *Ficus altissima* than non-figs plants can be attributed to the fewer availability of ripened fruit in the study site (Fleming et al. 1987; Shanahan et al. 2001; Kissling et al. 2007). Majorly, *Ficus* plants had ripened fruits during the survey. Whereas the neighboring non-figs plants were either in the flowering stage or had unripe fruits. The larger vertebrate assemblage at *Ficus* in our results also reflects the dispersal mechanism of the trees at PWS. The sampled hemi-epiphytic *Ficus* present their crop in the forest canopy and are generally considered bird dispersal species with a wide niche breadth. Therefore, they are capable of attracting a large diversity of birds and mammals including nomadic frugivores such as pigeons and hornbills (Lambert & Marshall 1991; Shanahan et al. 2001; Shanahan & Crompton 2001; Harrison & Shanahan 2005; Dutta & Rawatt 2008). For example, three-year study on frugivore and seed dispersal network in PWS recorded maximum number of frugivore birds in *Ficus* species, such as *Ficus drupacea* (25), *Ficus geniculata* (24), and *Ficus altissima* (20) (Naniwadekar et al. 2019). Consequently, these our findings are in line with the previous studies conducted in PWS which suggested greater vertebrate assemblages in *Ficus* species.

In southern Asian tropical forests, green pigeons (Lambert 1989a,b), bulbuls, barbets, hornbills (Kinnaird et al. 1996), and Asian fairy bluebird species are the primary groups of fig-eating birds (Corlett 1998; Shanahan et al. 2001; Sanitjan & Chen 2009; Barua & Tamuly 2011). The results demonstrated that the green

Table 1. Comparison of species assemblage among *Ficus* and non-figs (NF) plants.

Man-Whitney U test	<i>F. drupacea</i>	NF	<i>F. altissima</i>	NF	<i>F. variegata</i>	NF	<i>F. geniculata</i>	NF
Mann-Whitney U	23		32.5		3		27	
p (<0.05)	0.0095		0.0635		0.0002		0.0081	
Critical value	23		23		20		30	

Table 2. Vertebrate groups observed in the *Ficus* trees, mean number of Individuals, visiting frequency, visiting duration in each tree per scan and preference of vertebrate groups towards *Ficus* tree in percentage.

<i>Ficus</i> tree preference (%)			Visiting time duration/scan (Mean \pm sd)			Visiting frequency			Individuals/scan (Mean \pm sd)			Plant taxa
<i>F. geniculata</i>	<i>F. altissima</i>	<i>F. drupacea</i>	<i>F. geniculata</i>	<i>F. altissima</i>	<i>F. drupacea</i>	<i>F. geniculata</i>	<i>F. altissima</i>	<i>F. drupacea</i>	<i>F. geniculata</i>	<i>F. altissima</i>	<i>F. drupacea</i>	
95	0	5	148.2 \pm 79	4	28.88 \pm 28.01	1.00	0.09	0.73	40.42 \pm 31.64	2	13.5 \pm 10.82	Bulbuls
12	79	9	23.4 \pm 10.7	78.1 \pm 52.8	20.43 \pm 23.29	1.00	0.82	0.64	3.8 \pm 1.55	7.56 \pm 3.97	4.14 \pm 4.85	Barbets
18	69	12	116.5 \pm 65.1	152.9 \pm 108.2	85.9 \pm 46.9	0.83	0.82	0.64	48.3 \pm 36.2	115.2 \pm 74.3	47.3 \pm 29	G. pigeons
2	91	7	21.67 \pm 14.43	42 \pm 35.9	7 \pm 6.73	0.67	0.55	0.36	1.67 \pm 0.57	19.5 \pm 16.78	13 \pm 19.34	Hornbills
1	98	1	37.5 \pm 10.61	87.3 \pm 52.5	10.6 \pm 13.13	0.25	0.91	0.45	7.5 \pm 2.12	48.9 \pm 22.51	9 \pm 9.14	Mynas
98	0	2	65.5 \pm 62.7	–	8.67 \pm 3.06	0.17	0.00	0.27	2.5 \pm 1.35	–	1	Orioles
46	33	21	75.8 \pm 54.5	62.1 \pm 33.3	42.3 \pm 41.5	0.83	0.82	0.55	13.11 \pm 7.93	10.33 \pm 3.35	14.5 \pm 12.99	Fairy birds
99	1	0	68.5 \pm 82.8	6 \pm 3	–	0.75	0.27	0.00	9.83 \pm 10.7	1.667 \pm 0.57	–	Opportunists
34	54	12	70 \pm 43.6	83 \pm 52.3	27.33 \pm 23.86	0.50	0.18	0.55	9.33 \pm 3.51	17 \pm 0	3.71 \pm 5.02	Mammals

Table 3. Vertebrate assemblages and the dominant species recorded in *Ficus* plants in tropical regions across different time and habitat types. Data was collected from (Lambert 1989a; Barua & Tamuly 2011; Senitjan & Chen 2009; Shanahan 2000; Daru et al. 2015; Lok et al. 2013). LD = low disturbance, D = disturbed, F = Forest, A = agricultural matrix, U = urban. (*) = only bird diversity was recorded, (^) = Current study, Jan. = January, Sept. = September, Oct. = October.

Location	Year	Sample size	Sampling effort (h)	Sampling period	Species recorded (n)	Dominant species	Site type
Kuala Lumpur, Malaysia	1984–86	38	750	March–October	60*	Green Pigeons	LD
Borneo, Malaysia	1998–99	34	700	March–September	69	Bulbuls, Pigeons	D, F
China	2004–06	32	816	May–June	30*	Bulbuls	D, F
Nigeria	2007–09	12	–	March–June	48	Bulbuls, Yellow-fronted Tinker-bird	F
Assam, India	2009–10	59	177	September–September	67	Green Pigeons	A
Singapore	2013	43	–	–	104	Pigeons, Barbets	U
Arunachal Pradesh [^]	2019	4	89	January–May	64	Green Pigeons	F

pigeons dominated the vertebrate assemblage in *Ficus* in 89 h of observational study. It can be attributed to the voracious feeding nature of green pigeons, which are fig specialists that feed exclusively on figs (Lambert 1989a,b). Despite PWS having a rich faunal diversity, the

study still recorded poor mammal assemblages. It might be because due to the presence of observers, which prohibited them from approaching the fruiting trees. Also, the survey did not cover the nocturnal mammals that feed on *Ficus* (Krishna et al. 2013).

The contention arises that while figs are universally regarded as a crucial tropical resource, not all fig species offer an equal bounty to vertebrate fauna. The findings distinctly unveil variations in the preferences of vertebrate species for different *Ficus* species. Among the focal *Ficus* species, *Ficus drupacea* emerges as the least favored by vertebrates. This trend is likely a result of factors such as the species' smallest crop size ($n = 3,240$) (Sanitjan & Chen 2009) and differences in nutrient composition, notably calcium, potassium, and magnesium, among the focal *Ficus* species, despite its larger fig size. These particular nutrients play a pivotal role in eggshell development and bone growth (Kinnaird et al. 1999; Wendln & Runkle 2000; Daru et al. 2015). Minimal distinctions were noted for other *Ficus* parameters (see Appendix 4).

CONCLUSION

Hemi-epiphytic *Ficus* trees emerge as significant attractions for vertebrates, boasting a rich diversity of species and distinct appeal compared to fruiting and flowering non-figs plants. Notably, *Ficus altissima* becomes a favored choice for barbets, green pigeons, hornbills, mynas, and mammals, while *Ficus geniculata* exclusively draws bulbuls, orioles, Asian fairy bluebirds, and opportunistic feeders. Amidst the array of frugivorous bird species within the west bank of PWS, green pigeons, particularly the *Teron* species, stand out as primary beneficiaries. Despite various frugivorous birds present, pigeons dominate the West bank, averaging 70.2 individuals per scan. The findings reveal a tendency for vertebrate assemblages to cluster more in *Ficus* trees compared to non-figs plants, indicating intricate interactions between figs and frugivores. This study offers insights into *Ficus* trees' pivotal role, emphasizing their ecosystem significance, potential for vertebrate-centered tourism, and vital conservation role in an eco-tourism context.

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Appendix 1. Fruiting and flowering non-figs plants near focal *Ficus* trees.

Fruiting and flowering trees	Family	Phenology	No. of trees observed
<i>Canarium resiniferum</i>	Burseraceae	Fruiting	1
<i>Duabanga grandiflora</i>	Lythraceae	Flowering	5
<i>Sterculia villosa</i>	Sterculiaceae	Flowering	1
<i>Sterculia colorata</i>	Sterculiaceae	Flowering	4
<i>Tetrameles nudiflora</i>	Datiscaceae	Flowering	1
<i>Shorea robusta</i>	Dipterocarpaceae	Flowering	3
<i>Dysoxylum binectiriferum</i>	Meliaceae	Fruiting	3
<i>Polyalthia simiarum</i>	Annonaceae	Fruiting (unripe)	2
<i>Phlogacanthus thyrsoformis</i> (shrub)	Acanthaceae	Flowering	20
<i>Dillenia indica</i>	Dilleniaceae	Fruiting	1

Appendix 2. Vertebrates were recorded at focal *Ficus* with their vertebrate group based on feeding observations. Indirect observations (*), Common vertebrates between *Ficus* and non-fig plants (**), Indirect observations as well as common vertebrates between *Ficus* and non-fig plants (*^). F—frugivore | OP—opportunists | O—other birds.

Family	Name	Scientific name	V. group
Birds			
Bucerotidae	Great Hornbill	<i>Buceros bicornis</i>	F
	Wreathed Hornbill**	<i>Rhyticeros undulatus</i>	F
	Oriental Pied Hornbill**	<i>Anthracoeros albirostris</i>	F
Campephagidae	Large Cuckoo Shrike**	<i>Coracina macei</i>	OP
	Scarlet Minivet**	<i>Pericrocotus speciosus</i>	O
Chloropsidae	Golden-fronted Leafbird**	<i>Chloropsis aurifrons</i>	OP
	Orange-bellied Leafbird**	<i>Chloropsis hardwickii</i>	OP
Columbidae	Pin-tailed Green Pigeon	<i>Treron apicauda</i>	F
	Wedge-tailed Green Pigeon	<i>Treron sphenurus</i>	F
	Mountain Imperial Pigeon	<i>Ducula badia</i>	O
	Thick-billed Green Pigeon	<i>Treron curvirostra</i>	F
	Yellow-footed Green Pigeon	<i>Treron phoenicoptera</i>	F
	Barred Cuckoo Dove**	<i>Macropygia unchall</i>	O
Dicaeidae	Plain flowerpecker**	<i>Dicaeum minullum</i>	O
Falconidae	Common Kestrel	<i>Falco tinnunculus</i>	O
Irenidae	Asian Fairy-bluebird	<i>Irena puella</i>	F
Leiothrichidae	Blue-winged Minla	<i>Actinodura cyanouroptera</i>	O
	Silver-eared Mesia	<i>Leiothrix argentea</i>	O
Megalaimidae	Blue-throated Barbet**	<i>Psilopogon asiaticus</i>	F
	Blue-eared Barbet	<i>Psilopogon cyanotis</i>	F
	Lineated Barbet**	<i>Psilopogon lineatus</i>	F
Muscicapidae	Grey-headed Canary Flycatcher**	<i>Culicicapa ceylonensis</i>	O
	Little Pied Flycatcher	<i>Ficedula westermanni</i>	O
Nectariniidae	Streaked spiderhunter**	<i>Arachnothera magna</i>	O
Oriolidae	Black hooded Oriole**	<i>Oriolus xanthornus</i>	F
	Maroon Oriole**	<i>Oriolus traillii</i>	F
Paridae	Sultan Tit	<i>Melanochlora sultanea</i>	O

Family	Name	Scientific name	V. group
Phasianidae	Red junglefowl	<i>Gallus gallus</i>	O
	Khalij Pheasant	<i>Lophura leucomelanos</i>	O
Picidae	Greater yellow-napped Woodpecker**	<i>Chrysophlegma flavinucha</i>	O
	Grey-caped Pygmy Woodpecker**	<i>Yungipicus canicapillus</i>	O
Pycnonotidae	White-throated Bulbul	<i>Alophixus flaveolus</i>	F
	Black-crested Bulbul**	<i>Pycnonotus flaviventris</i>	F
	Black Bulbul	<i>Hypsipetes leucocephalus</i>	F
	Red-vented Bulbul	<i>Pycnonotus cafer</i>	F
	Mountain Bulbul	<i>Ixos mccllellandii</i>	F
	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	F
Sittidae	Chestnut-bellied nuthatch	<i>Sitta cinnamoventris</i>	O
Sturnidae	Common Hill Myna	<i>Gracula religiosa</i>	F
Timaliidae	Greater Necklaced Laughingthrush	<i>Pterorhinus pectoralis</i>	O
Vangidae	Large Woodshrike**	<i>Tephrodornis virgatus</i>	O
Zosteropidae	Oriental White-eye	<i>Zosterops palpebrosus</i>	O
	Whiskered Yuhina	<i>Yuhina flavicollis</i>	OP
Mammal			
Bovidae	Gaur*	<i>Bos gaurus</i>	
Cervidae	Sambar deer*^	<i>Rusa unicorn</i>	
	Barking deer*^	<i>Muntiacus muntjak</i>	
Cercopithecidae	Rhesus macaque	<i>Macaca mulatta</i>	
	Assamese macaque	<i>Macaca assamensis</i>	
Pteropodidae	Indian flying fox*	<i>Pteropus giganteus</i>	
Sciuridae	Malayan giant squirrel	<i>Ratufa bicolor</i>	
	Hoary bellied squirrel*^	<i>Callosciurus pygerythrus</i>	
	Palla's squirrel	<i>Callosciurus erythraeus</i>	
Suidae	Wild boar*^	<i>Sus scrofa</i>	
Viverridae	Common palm civet	<i>Paradoxurus hermaphroditus</i>	

Appendix 3. Checklist of birds recorded during scan sampling including vertebrates recorded in the west bank, Pakke Wildlife Sanctuary. Vertebrates recorded in non-figs (*), Unique to non-figs ().**

Family	Name	Scientific name	IUCN
Accipitridae	Oriental Honey-buzzard	<i>Pernis ptilorhynchus</i>	LC
	Crested Serpent-Eagle	<i>Spilornis cheela</i>	LC
Artamidae	Ashy Woodswallow	<i>Artamus fuscus</i>	LC
Bucerotidae	Great Hornbill	<i>Buceros bicornis</i>	VU
	Wreathed Hornbill*	<i>Rhyticeros undulatus</i>	VU
	Oriental Pied-Hornbill*	<i>Anthraceroceros albirostris</i>	LC
Campephagidae	Large Cuckooshrike*	<i>Coracina macei</i>	LC
	Scarlet Minivet*	<i>Pericrocotus speciosus</i>	LC
	Long-tailed Minivet	<i>Pericrocotus ethologus</i>	LC
Cettiidae	Grey-bellied Tesia	<i>Tesia cyaniventer</i>	LC
Chloropsidae	Golden-fronted Leafbird*	<i>Chloropsis aurifrons</i>	LC
	Orange-bellied Leafbird*	<i>Chloropsis hardwickii</i>	LC
Ciconiidae	Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	NT
Cisticolidae	Common Tailorbird	<i>Orthotomus sutorius</i>	LC
Columbidae	Pin-tailed Green Pigeon	<i>Treron apicauda</i>	LC
	Wedge-tailed Green Pigeon	<i>Treron sphenurus</i>	LC
	Mountain Imperial-Pigeon	<i>Ducula badia</i>	LC
	Thick-billed Green Pigeon	<i>Treron curvirostra</i>	LC
	Yellow-footed Green Pigeon	<i>Treron phoenicoptera</i>	LC
	Asian Emerald dove	<i>Chalcophaps indica</i>	LC
	Barred Cuckoo-dove*	<i>Macropygia unchall</i>	LC
	Oriental Turtle Dove	<i>Streptopelia orientalis</i>	LC
Coraciidae	Indian Roller	<i>Coracias benghalensis</i>	LC
	Oriental Dollarbird**	<i>Eurystomus orientalis</i>	LC
Cuculidae	Square-tailed Drongo-cuckoo	<i>Surniculus lugubris</i>	LC
	Banded Bay Cuckoo	<i>Cacomantis sonneratii</i>	LC
	Green-billed Malkoha	<i>Phaenicophaeus tristis</i>	LC
Dicaeidae	Plain Flowerpecker*	<i>Dicaeum minullum</i>	LC
Dicruridae	Ashy Drongo**	<i>Dicrurus leucophaeus</i>	LC
	Spangled Drongo**	<i>Dicrurus bracteatus</i>	LC
	Greater Racket-tailed Drongo	<i>Dicrurus paradiseus</i>	LC
	Lesser Racket-tailed Drongo	<i>Dicrurus remifer</i>	LC
Eurylaimidae	Long-tailed Broadbill	<i>Psarisomus dalhousiae</i>	LC
Falconidae	Eurasian Kestrel	<i>Falco tinnunculus</i>	LC

Family	Name	Scientific name	IUCN
Irenidae	Asian Fairy-bluebird	<i>Irena puella</i>	LC
Laniidae	Brown Shrike**	<i>Lanius cristatus</i>	LC
	Long-tailed Shrike	<i>Lanius schach</i>	LC
Leiothrichidae	Red-tailed Minla	<i>Minla ignotincta</i>	LC
	Blue-winged Minla	<i>Actinodura cyanouroptera</i>	LC
	Silver-eared Mesia	<i>Leiothrix argentauris</i>	LC
	Rufous-backed Sibia	<i>Heterophasia annectens</i>	LC
Megalaimidae	Blue-throated Barbet*	<i>Psilopogon asiaticus</i>	LC
	Blue-eared Barbet	<i>Psilopogon cyanotis</i>	LC
	Lineated Barbet*	<i>Psilopogon lineatus</i>	LC
Meropidae	Chestnut-headed Bee-eater**	<i>Merops leschenaultia</i>	LC
	Blue bearded Bee-eater	<i>Nyctornis athertoni</i>	LC
Monarchidae	Black-naped Monarch	<i>Hypothymis azurea</i>	LC
Muscicapidae	Grey-headed Canary-Flycatcher*	<i>Culicicapa ceylonensis</i>	LC
	Little Pied Flycatcher	<i>Ficedula westermanni</i>	LC
	Verditer Flycatcher	<i>Eumyias thalassinus</i>	LC
	Pale blue Flycatcher	<i>Cyornis unicolor</i>	LC
	Chestnut-bellied Rock-Thrush	<i>Monticola rufiventris</i>	LC
	Blue Rock-Thrush	<i>Monticola solitarius</i>	LC
	Small Niltava**	<i>Niltava macgrigoriae</i>	LC
	Hodgson's Redstart	<i>Phoenicurus hodgsoni</i>	LC
	Grey Bushchat	<i>Saxicola ferreus</i>	LC
	White-rumped Shama	<i>Copsychus malabaricus</i>	LC
	Blue-Whistling Thrush	<i>Myophonus caeruleus</i>	LC
Nectariniidae	Streaked Spiderhunter*	<i>Arachnothera magna</i>	LC
	Little Spiderhunter**	<i>Arachnothera longirostra</i>	LC
Oriolidae	Black-hooded Oriole*	<i>Oriolus xanthornus</i>	LC
	Maroon Oriole*	<i>Oriolus traillii</i>	LC
Paridae	Sultan Tit	<i>Melanochlora sultanea</i>	LC
Phasianidae	Red junglefowl	<i>Gallus gallus</i>	LC
	Khalij Pheasant	<i>Lophura leucomelanos</i>	LC
	Grey Peacock-Pheasant.	<i>Polyplectron bicalcaratum</i>	LC
Phylloscopidae	Tickell's Leaf Warbler**	<i>Phylloscopus affinis</i>	LC
	Greenish Warbler	<i>Phylloscopus trochiloides</i>	LC
Picidae	Greater Yellow-nape Woodpecker*	<i>Chrysophlegma flavinucha</i>	LC

Family	Name	Scientific name	IUCN
	Grey-capped Pygmy Woodpecker*	<i>Picoides canicapillus</i>	LC
	Greater flame back Woodpecker	<i>Chrysocolaptes guttacristatus</i>	LC
	Fulvous breasted Woodpecker	<i>Dendrocopos macei</i>	LC
	Grey-headed Woodpecker	<i>Picus canus</i>	LC
	Lesser Yellownappe Woodpecker	<i>Picus chlorolophus</i>	LC
	Rufous Woodpecker	<i>Rufous woodpecker</i>	LC
Pellorneidae	Abbott's Babbler	<i>Malacocincla abbotti</i>	LC
Psittaculidae	Red-breasted Parakeet**	<i>Psittacula alexandri</i>	NT
Pycnonotidae	White-throated Bulbul	<i>Alophaius flaveolus</i>	LC
	Black-crested Bulbul*	<i>Pycnonotus flaviventris</i>	LC
	Black Bulbul	<i>Hypsipetes leucocephalus</i>	LC
	Red-vented Bulbul	<i>Pycnonotus cafer</i>	LC
	Mountain Bulbul	<i>Ixos mcclllandii</i>	LC
	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	LC
Rhipiduridae	White-throated Fantail	<i>Rhipidura albicollis</i>	LC
Sittidae	White-tailed Nuthatch	<i>Sitta himalayensis</i>	LC
	Chestnut-bellied Nuthatch	<i>Sitta cinnamoventris</i>	LC
Stenostiridae	Yellow-bellied Fantail**	<i>Chelidorhynch hypoxantha</i>	LC
Strigidae	Asian Barred Owlet	<i>Glaucidium cuculoides</i>	LC
	Spotted Owlet	<i>Athene brama</i>	LC

Family	Name	Scientific name	IUCN
	Collared Owlet	<i>Glaucidium brodiei</i>	LC
Sturnidae	Chestnut-tailed Starling	<i>Sturnia malabarica</i>	LC
	Common Hill Myna	<i>Gracula religiosa</i>	LC
Timaliidae	Lesser Necklaced laughingthrush	<i>Garrulax monileger</i>	LC
	Greater Necklaced laughingthrush	<i>Pterorhinus pectoralis</i>	LC
Vangidae	Large Woodshrike*	<i>Tephrodornis virgatus</i>	LC
	Common Woodshrike	<i>Tephrodornis pondicerianus</i>	LC
Zosteropidae	Oriental White-eye	<i>Zosterops palpebrosus</i>	LC
	Whiskered Yuhina	<i>Yuhina flavicollis</i>	LC
Mammal			
Bovidae	Gaur	<i>Bos gaurus</i>	VU
Cervidae	Sambar deer*	<i>Rusa unicolor</i>	VU
	Barking deer*	<i>Muntiacus muntjak</i>	LC
Cercopithecidae	Rhesus macaque	<i>Macaca mulatta</i>	LC
	Assamese macaque	<i>Macaca assamensis</i>	LC
Pteropodidae	Indian flying fox	<i>Pteropus giganteus</i>	LC
Sciuridae	Malayan giant squirrel	<i>Ratufa bicolor</i>	LC
	Hoary-bellied squirrel*	<i>Callosciurus pygerythrus</i>	LC
	Palla's squirrel	<i>Callosciurus erythraeus</i>	LC
Suidae	Wild boar*	<i>Sus scrofa</i>	LC
Viverridae	Common palm civet	<i>Paradoxurus hermaphroditus</i>	LC

Appendix 4. Fig characteristics of focal *Ficus* species. L = length, B = breadth.

Characteristics	<i>Ficus drupacea</i>	<i>Ficus geniculata</i>	<i>Ficus altissima</i>	<i>Ficus variegata</i>
Growth form	Hemiepiphyte	Hemiepiphyte	Hemiepiphyte	Tree
Crop size	3240	2058000	300000	11790
Fruit shape	Globular	Round	round	Pear shape
Fig size (mm)	L = 33, D = 25	L = 9, D = 9	L = 21, D = 20	L = 34, D = 45
Fruit colour	Black-yellow	Green	Yellow-red	red
Fruit placement	Axillary	Axillary	Axillary	Cauliflory
GBH (m)	6	9.1	7.2	2.43
Height (m)	23	32	26	16
Phenology	Fruiting (ripe)	Fruiting (ripe)	Fruiting (ripe)	Fruiting (ripe)



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ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

October 2023 | Vol. 15 | No. 10 | Pages: 23931–24150

Date of Publication: 26 October 2023 (Online & Print)

DOI: 10.11609/jott.2023.15.10.23931-24150

www.threatenedtaxa.org

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