Tree habitat heterogeneity and its utilization pattern by Bird community at Pakke Tiger Reserve, Arunachal Pradesh

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Understanding the ecology of tropical bird communities improves conservation efforts. Functional changes from distinct habitats such as lowland forests, bamboo habitats and riverine ecosystems are of great interest in tracing the alteration of birds' ecosystem services. Habitats are an essential ecosystem of all kinds of bird species, from ground feeding to aerial feeding. Pakke Tiger Reserve is a stratified landscape comprising various small river catchment areas, bamboo habitats and classified forests. Pakke Tiger Reserve (PTR), located between 920 7.5' to 920 22' E and 260 3.7' E to 270 16.2' N, covers 861.95 km2 in the Pakke Kessang district of Arunachal Pradesh. The principal objective was to monitor and determine the density, diversity and abundance of avian species in the stratified habitat of PTR. The point count distance sampling method was used to estimate bird species in selected habitats, i.e. riverine, bamboo and forest. Habitat was assessed in pre-selected point counts, and the forest was found to be as dominating habitat, followed by riverine and Bamboo. The highest number of tree species was recorded in forest habitat, 53 species, followed by riverine, 35 species, and least in bamboo habitat, ten species. The highest number of bird species was recorded from forest habitat, 169 sp, followed by bamboo habitat, 123 sp. and riverine habitat, 120 sp. Seven tree variables were selected to check out the interaction between tree and bird species richness, and the results direct the positive effect of the overall independent variables. The dependent variable showed a significant impact with overall independent variables, *F*6,14=2.89, *p*=0.05, indicating that all independent variables can significantly increase bird species richness. Forests are the most dominating habitat used by birds because various bird species use the height of trees for their different foraging activity, courtship, mating, and nesting.

1. **Introduction**

The bird’s diversity is an important biological marker for evaluating the fitness of terrestrial and aquatic habitat qualities in all respects (Chamberlain *et al*., 2005; Rotenberry & Wiens, 2009; Mistry & Mukherjee, 2015). Forests are the most significant habitat for birds as they support around 75% of all avifauna species, while only 45% have adapted to human-modified habitats (Birdlife International, 2018). Avifauna is habitat-specific, and some can occupy more than one habitat type; however, because of land-use changes, many birds have been displaced from their native habitats (Burgess *et al.,* 2002). The capacity to fly is helpful in their survival through shifting from one habitat to another during an unfavourable period or extreme adverse environmental conditions. Birds are a visible and integral part of the ecosystem, occupying many trophic levels in a food chain that range from consumers to predators (Bideberi, 2013). Birds are highly susceptible to changes in habitat caused by human use and modifications (Raman *et al.,* 1998; Lohr *et al.,* 2002) and are considered indicators of biological richness and the health of our environment, plant pollination, seed dispersal as well as pest control (Hadley *et al.,* 2012; Ramchandra, 2013). In most habitats, plant communities determine the body of the environment and, thus, have a substantial influence on birds' distribution, abundance, and diversity. The structure of a forest community is closely related to many functional characteristics of the forest, such as the formation of different micro-climates, tree growth, and enhancement of community stability (O’Hara *et al.,* 1996; Chen *et al.,* 1997). For instance, Tews *et al.* (2004) reported that the composition of plant community and structure had influenced bird species diversity. Spatially heterogeneous forests may accommodate more species and particular species requiring specialized microhabitats (Atwell *et al.,* 2008), like providing breeding or roosting opportunities and feeding substrates, etc., compared to less homogenous forests. Also, the complexity of vertical vegetation structure is related to the number of insect and avian species occupying a given forest area (Berg & Part, 1994). Thus, structurally complex forests provide more diverse conditions than homogenous forests because of a greater variety of microhabitats and vegetation.

This sensitivity suggests that bird communities have a high potential to act as a surrogate for their habitats at structural, regional, and landscape-level management (Canterbury *et al.,* 2000; Lindenmayer *et al.,* 2000; O’Connell *et al*., 2000). For example, nectarivorous bird species pollinate dependent plant species, contributing to the exchange of unrelated genetic material between areas. Frugivorous bird species consume and disperse seeds, improve their germination and are responsible for the genetic exchanges between areas. Moreover, they can contribute to the recolonization and restoration of disturbed ecosystems. Insectivorous bird species control insect populations and can be an alternative to pesticides as they reduce plant damage, which can also be of great economic importance (Sekercioğlu *et al.,* 2004). The degradation of habitat caused by non-essential and unfavourable practices pressed upon anthropogenically is a significant factor in eliminating bird community populations (Palmer *et al.,* 2004; Sidra *et al.,* 2013). Fragmentation in the habitats is one of the results of anthropogenic factors causing the loss of species and, further unchecked, leading to species extinction (Subramanya, 1996).

A vast number of the previous studies sought to establish relationships between bird species diversity and habitat attributes like vegetation structure and heterogeneity (MacArthur & MacArthur 1961; Wilson, 1974; Roth, 1976; James & Wamer, 1982). Avifauna have been considered good predictors of habitat quality, as they relate to changes in their associated habitats in numerous ways (Raman *et al.,* 1998; Chettri *et al.,* 2001) because they respond to habitat structure (MacArthur & MacArthur, 1961) and represent several tropic groups (Steele *et al.,* 1984). The distribution of many bird communities is affected by habitat fragmentation or other habitat parameters and reflects inter-specific dynamics and population trends associated with the habitat (O’Connell *et al.,* 2000).

1. **STUDY AREA AND METHODS**
2. **Study area**

Arunachal Pradesh, located between 26º28’ to 29º30’ N and 91º30’ to 97º30’ E with 83,743 km2 in north-eastern India, lies in the Eastern Himalayan biodiversity hotspot. The state’s eastern edges lie in the confluence of the Eastern Himalayan, Indo-Malayan biodiversity hotspot. There are 13 Wildlife Sanctuaries, 1 Orchid Sanctuary and 2 National Parks in the state of Arunachal Pradesh, covering an area of 9,488.48 sq. km. The area has excellent biological significance due to the richness of flora and fauna, as the area falls under the Oriental and the Indo-Malayan Realm. It has been considered one of the hotspots for biodiversity (Myers, 1990). The area has a subtropical climate with cold weather from November to March. It receives rainfall from the southwest (May-September) and northeast monsoons (November-April). The temperature in the summer goes up to 30° C and goes down to 2° C in the winter. The topography of the tiger reserve is undulating and hilly. The altitudinal variations start from 150 to 2040 m above mean sea level. Thus, the PTR is surrounded by contiguous forests, undulating terrain, and hills on most sides, with higher elevations in the northern part of the reserve. The vegetation of PTR is Assam Valley type (2B/C1); tropical semi-evergreen with a high density and diversity of trees, woody lianas and climbers (Champion & Seth, 1968). Tropical, semi-evergreen forests dominate the lower plains and foothills, while subtropical, broadleaved, evergreen and dense forests occur at elevations of 900 to 1,800 m above sea level.



**Figure 1. Study area map with sampling points in selected habitats.**

1. **Methodology**

The present study was carried out for two consecutive years from 2020 to 2021 on two major seasonal bases: pre-monsoon and post-monsoon season. The study area was divided into three major habitat types based on the availability of bird species. A systematic field survey was carried out using the point count distance sampling method (Bibby *et al.,* 1992) to estimate the species diversity and population attributes of avifauna found across different selected habitat types. The point count distance sampling method is widely used to estimate biological populations' diversity, density and abundance. A total of 164 sampling points were laid in the entire landscape in selected habitat types (Forest; 109 points, Bamboo; 25 points, and Riverine; 30 points)

The quadrate sampling method as described by (Schemnitz, 1980) was used to assess the habitat structure and community characteristics of the trees found in the selected habitats of study site. Quadrates were placed in each point station or sampling points by considering the species-area richness curve in relatively leveled areas in selected habitats (*viz.* Forest, Riverine, bamboo dominated forest) (Photo plate 1) comprising the entire representative avian census area of PTR. Quadrate size of 10m X 10m was used the study of tree layer. In each quadrate, number of tree species and their individual, tree height, tree canopy cover using vertical-point intercept (Jennings *et al.,* 1999) and Girth at Breast Height (GBH) in 1.37 m above from the ground was recorded.

1. **RESULT**

Overall, a total of 67 tree species from 34 families were recorded during the study periods. The highest number of tree species with individuals was recorded in forest habitat (53 species, 426 individuals (4.35±0.84)), followed by riverine (35 species, 117 individual (1.6±0.34)) and least in bamboo habitat (10 species, 65 individual (0.23±0.07)). Family Malvaceae (9.5%, n=6) was recorded as the dominating family, followed by Meliaceae, Moraceae (7.9%, n=5 each), Burseraceae, Elaeocarpaceae, Fabaceae, Lauraceae, Magnoliaceae (6.3%, n=4 each), Achariaceae, Lythraceae, Phyllanthaceae, (3.2%, n=2 each), and rest of the family comprises only one individual of the species (1.49%, n=1 each).

The result reveals that the bird species richness was found dominant in the forest habitat (169 species), followed by bamboo (123 species) and riverine (120), while 72 species shared all three habitats. However, when compared with two different habitats, it was found that forest and bamboo habitat had 98 common species, and forest and riverine habitat had 97 common species which was almost similar because forest, riverine and Bamboo habitat was merged habitat with little dominant of each habitat. Whereas riverine and bamboo habitats had 80 common species in the riverine habitat species was very specific and they usually don’t share their habitat.

**Riverine**

**(120)**

**Forest**

**(169)**

**Bamboo**

**(123)**

**98**

**80**

**97**

**72**

**Figure 2. Vein diagram showing the common bird species shared two different habitats.**

1. **Seasonal variation in diversity indices of bird species in selected habitats**

Based on the selected habitats, species richness was recorded highest in the post-monsoon season of the second year in forest habitats and lowest in the pre-monsoon season of first year in riverine habitats because during post-monsoon many migratory bird species coming to the Pakke Tiger Reserve as many bird species follow the Pakke river for migration such as Black-necked Stork, Ibis Bill, Common Merganser etc. Shannon diversity index (H) was highest in the post-monsoon season of second year in forest habitat (3.93), whereas it was lowest in the post-monsoon season of the first year in riverine habitat (3.32). The Simpson diversity index was highest in the post-monsoon season of second year in bamboo habitats (0.97) and lowest in the pre-monsoon season of first year in forest habitats (0.92). Dominance was highest (0.078) in the pre-monsoon season of first year in forest habitats and lowest (0.031) in the post-monsoon season of the second year in the bamboo habitat. The species evenness was recorded the highest (0.65) in the post-monsoon season in the second year and lowest (0.24) in pre-monsoon in the first year (Table 1).

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| **Table 1**. **Variation in diversity indices in different habitats** |
|  | **Habitat** | **Dominance** | **Simpson** | **Shannon** | **Evenness** |
| Pre-monsoon 2020 | Bamboo | 0.063 | 0.94 | 3.56 | 0.42 |
| Forest | 0.078 | 0.92 | 3.39 | 0.24 |
| Riverine | 0.053 | 0.95 | 3.47 | 0.50 |
|  |  |  |  |  |  |
| Post-monsoon 2020 | Bamboo | 0.040 | 0.96 | 3.64 | 0.57 |
| Forest | 0.075 | 0.93 | 3.55 | 0.27 |
| Riverine | 0.073 | 0.93 | 3.32 | 0.40 |
| Pre-monsoon 2021 | Bamboo | 0.054 | 0.95 | 3.43 | 0.45 |
| Forest | 0.066 | 0.93 | 3.61 | 0.28 |
| Riverine | 0.057 | 0.94 | 3.52 | 0.48 |
| Post-monsoon 2021 | Bamboo | 0.031 | 0.97 | 3.80 | 0.65 |
| Forest | 0.042 | 0.96 | 3.93 | 0.39 |
| Riverine | 0.044 | 0.96 | 3.68 | 0.53 |

1. **Seasonal variation in density of birds in selected habitat**

The highest group density was recorded in the pre-monsoon season of first year in the bamboo habitat (71.47±10.89/km2) and the lowest in the pre-monsoon season of the second year in the riverine habitat (27.065±3.42/km2). Whereas the highest individual density was recorded in the pre-monsoon season of first year in bamboo habitat (516.78±78.83/km2) and the lowest in the pre-monsoon of second year in riverine habitat (274.25±34.81/km2) (Table 2). Overall, detection probability was a maximum (85.3%) in the second year of pre-monsoon season in riverine habitat and minimum (38.7%) in the first year of pre-monsoon in Bamboo.

In bamboo habitat, detection probability was lowest in pre-monsoon season of the first year and highest in post-monsoon season of first year (Table 2), whereas in the forest habitat lowest detection probability was recorded in pre-monsoon season of the first year and highest in the post-monsoon season of the second year with respect to radial distance (Table 2). In case of riverine habitat bird detection probability was the highest in the pre-monsoon season of second year and lowest in post-monsoon season of first year with respect to radial distance (Table 2).

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| **Table 2. Seasonal variation of bird species detection probability, density of cluster, density, effective density radius, and encounter rate in selected habitats** |
| **Season** | **Habitat** | **DP** | **ER** | **DS** | **D** | **EDR** |
| Pre-Monsoon 2020 | Bamboo | 38.7 | 61.2 | 71.47±10.89 | 516.78±78.83 | 21.18±1.0 |
| Forest | 52.2 | 47.4 | 57.72±4.05 | 413.77±29.05 | 21.66±0.54 |
| Riverine | 65.9 | 33.8 | 42.28±5.56 | 337.83±44.55 | 23.49±1.25 |
| Post-Monsoon 2020  | Bamboo | 77.2 | 21.6 | 60.79±7.06 | 424.16±49.58 | 21.24±1.09 |
| Forest | 61.0 | 38.6 | 55.43±3.49 | 430.81±27.26 | 23.22±0.57 |
| Riverine | 65.0 | 34.4 | 46.61±5.95 | 363±46.54 | 22.98±1.18 |
| Pre-Monsoon 2021 | Bamboo | 65.1 | 34.6 | 54.69±6.97 | 429.24±54.8 | 23.54±1.22 |
| Forest | 65.7 | 33.8 | 55.61± 3.31 | 432.81±25.88 | 23.73±0.57 |
| Riverine | 85.3 | 14.0 | 27.06±3.42 | 274.25±34.81 | 31.31±1.83 |
| Post-Monsoon 2021 | Bamboo | 73.6 | 24.8 | 55.79±6.69 | 394.99±47.77 | 22.91±1.18 |
| Forest | 68.1 | 31.2 | 56.69±3.27 | 448.66±26.01 | 23.87±0.57 |
| Riverine | 81.0 | 18.2 | 35.9±4.22 | 332.51±39.25 | 28.04±1.49 |
| DP= Detection probability, DS= Density of cluster (Number/km2), D= Density of individual (Number/km2), EDR= Effective density radius (m), ER= Encounter rate (individual/km) |

Correlation analysis was carried out between seven habitat variables and bird species richness. Findings of the present study revealed a strong positive correlation between the number of tree individuals with the number of bird species and a number of bird individuals. Whereas GBH and height showed a negative correlation with the number of bird species and number of bird species individuals (Table 3). The result explained that bird species richness depends on proper growth of trees in Height, GBH, Crown cover and number of tree individual.

| **Table 3.** **Correlation matrix between habitat variables and bird species and individuals** |
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| **Variable** | Tree\_Species | Tree\_Ind | GBH | Height | Crown\_cover | Bird\_species | Bird\_Ind |
| Tree\_Species | 1 |  |  |  |  |  |  |
| Tree\_Ind | 0.885 | 1 |  |  |  |  |  |
| GBH | -0.792 | -0.417 | 1 |  |  |  |  |
| Height | -0.641 | -0.211 | 0.976 | 1 |  |  |  |
| Crown\_cover | 0.892 | **1.00\*\*** | -0.430 | -0.224 | 1 |  |  |
| Bird\_species | 0.855 | **0.998\*** | -0.360 | -0.150 | **0.997\*** | 1 |  |
| Bird\_Ind | 0.820 | 0.992 | -0.300 | -0.087 | 0.990 | 0.998\* | 1 |
| \*\* Correlation is significant at the 0.01 level (2-tailed)\* Correlation is significant at the 0.05 level (2-tailed) |

Principal component analysis (PCA) was carried out on seven standardized habitat variables (Fig. 3) and resulted in the extraction of principal components (Eigenvalues greater than 1) that collectively explained 74.23% of the total variation in the habitat variables. The study reveals that the relationship between avifauna species richness and habitat patterns/structure addresses the effects of habitat variables on avian species richness and distribution patterns (Fig. 3).

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**Figure 3.** **Principle component analysis showing interaction between all the dependent and independent variables.**

Birds are dependent on trees for various activity such as nesting, feeding, roosting and foraging. So five variables of trees were taken to understand bird dependency on tree species. The hypothesis tested tree species, tree individual, tree crown cover, GBH and height carries a significant impact on bird species richness. These results clearly direct the positive effect of the overall independent variables. The dependant variable (bird species richness) was showing significant impact with overall independent variables, *F*6,14=2.89, *p*=0.05, which indicates that the all-independent variables can play a significant role in increasing bird species richness (Table 4). The hypothesis tested proves that with low numbers of tree bird population will decrease because they are fully dependent on tree species.

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| **Table 4.**  **Descriptive results of one-way ANOVA** |  |
| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
| Between Groups | 31142362.59 | 6 | 5190393.76 | 2.88698 | 0.047884 | 2.847726 |
| Within Groups | 25170075.16 | 14 | 1797862.51 |  |  |  |
| **Total** | **56312437.74** | **20** |  |  |  |  |
| \*SS- sum of square, *df*- degree of freedom, MS- mean square, *F* crit - *F* critical |

1. **Discussion**

Bird species mainly depend on trees for nesting, feeding and foraging. The present study maximized sampling points in the forest habitat because of the low detection of species in the dense forest compared to the bamboo and riverine habitat. Consequently, maximum bird species were recorded in the forest habitat, followed by the riverine and bamboo habitat. In the present study, *Tetrameles nudiflora* was the dominant tree species in the forest habitat, which is used by hornbills and many other birds for nesting, such as woodpeckers, mynas, barbet, roller birds & parakeets. *Tetrameles Nudiflora* is flowering and fruiting from March to May (Page *et al.,* 2022) and provides a foraging place for many seasonal birds.

On the other hand, *Duabanga grandiflora* is dominated in riverine and bamboo habitats. This tree is used as camaflouge hide by green colour birds and birds of prey and used for nesting and foraging activities by small bird species. The visit of birds to individual trees depends on the tree's condition: height, canopy surface, crown cover and flowers and berries (Zwarts *et al.,* 2015). Forest birds generally select a breeding habitat based on gross vegetational structure (Hilden, 1965; Klopfer & Hailman, 1965; James, 1971; Robinson & Holmes, 1982; Smith & Shugart, 1987). James (1971) coined the term "niche gestalt" to refer to the characteristic vegetational profile associated with the breeding territory of a particular species. The niche gestalt has been a beneficial construct in avian ecology because it can be readily quantified with simple measures of vegetation structure and summarized by multivariate statistical techniques (James, 1971; Capen, 1981).

In the present study, the highest number of bird species was recorded from forest habitats, which are a consequence of a typical forest bird defending a breeding territory that provides good nest sites (Martin, 1971; Zimmerman, 1971; Calder, 1973), foraging areas (Partridge, 1976), and prey abundance (Miller, 1931; Howell, 1952; Stenger & Falls, 1959; Cody, 1968). Thus, "habitat" encompasses other niche dimensions (e.g., trophic relations) and can be considered a fundamental resource base for forest birds in the sense of Grinnell (1917) or Hutchinson (1957). Birds are not always dependent on the factors related to survival but also, psychically, on a particular type of landscape (Von Haartman, 1948; Bergman, 1946; Fabricius, 1951). Every plant has a definite period of flowering and fruiting, albeit strongly controlled by climatic factors and evolutionary processes (Silva *et al*., 2011). These phenological events ultimately determine the reproductive success of plants (Carvalho & Sartori, 2015). The drastic change in the phonological condition of the particular region could be attributed to climate change or periodic drought, flood, or genetic factors affecting the avifauna species.

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**Appendix 1.** Checklist of Tree species of Pakke Tiger Reserve with their abundance in selected habitat

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S. N.** | **Tree species** | **Family** | **Forest** | **Riverine** | **Bamboo** |
| 1. | *Gynocardia odorata* R. Br. | Achariaceae | 0 | 1 | 0 |
| 2. | *Saurauia roxburghii* Wall. | Actinidiaceae | 0 | 1 | 0 |
| 3. | *Liquidambar excelsa* (Noronha) Oken | Altingiaceae | 0 | 3 | 0 |
| 4. | *Litsea glutinosa* (Lour.) C.B. Rob. | Altingiaceae | 1 | 0 | 0 |
| 5. | *Rhus chinensis* Mill. | Anacardiaceae | 1 | 0 | 0 |
| 6. | *Polyalthia simiarum* (Buch. Ham. ex Hook.f. & Thomson) Hook.f. &Thomson | Annonaceae | 2 | 0 | 0 |
| 7. | *Brassaiopsis glomerulata* (Blume) Regel | Araliaceae | 2 | 0 | 0 |
| 8. | *Livistona jenkinsiana* Griff. | Arecaceae | 3 | 1 | 0 |
| 9. | *Stereospermum chelonoides* (L. fil.) DC. | Bignoniaceae | 4 | 4 | 0 |
| 10. | *Ehretia acuminata* R. Br. | Boraginaceae | 1 | 0 | 0 |
| 11. | *Canarium resiniferum* Bruce ex King | Burseraceae | 23 | 2 | 0 |
| 12. | *Canarium strictum* Roxb. | Burseraceae | 3 | 0 | 0 |
| 13. | *Garuga floribunda* Decne. | Burseraceae | 0 | 2 | 0 |
| 14. | *Garuga pinnata* Roxb. | Burseraceae | 1 | 0 | 0 |
| 15. | *Mesua ferrea* L. | Calophyllaceae | 2 | 0 | 0 |
| 16. | *Crateva religiosa* G. Forst. | Capparaceae | 5 | 0 | 0 |
| 17. | *Terminalia myriocarpa* Van Heurck & Mull. Arg. | Combretaceae | 7 | 11 | 3 |
| 18. | *Dillenia indica* L. | Dilleniaceae | 14 | 8 | 1 |
| 19. | *Dipterocapus retusus* Blume | Dipterocarpaceae | 0 | 1 | 0 |
| 20. | *Elaeocarpus aristatus* Roxb. | Elaeocarpaceae | 6 | 4 | 0 |
| 21. | *Elaeocarpus robustus* Roxb. | Elaeocarpaceae | 0 | 1 | 0 |
| 22. | *Sloanea sterculiacea* (Benth.) Rehder & E. H. Wilson | Elaeocarpaceae | 2 | 1 | 0 |
| 23. | *Glochidion assamicum* (Mull. Arg.) Hook.f. | Euphorbiaceae | 1 | 0 | 0 |
| 24. | *Macaranga denticulata* (Blume) Mull. Arg. | Euphorbiaceae | 2 | 3 | 0 |
| 25. | *Albizia procera* (Roxb.)Benth. | Fabaceae | 5 | 1 | 2 |
| 26. | *Bauhinia purpurea* L. | Fabaceae | 1 | 0 | 0 |
| 27. | *Bauhinia racemosa* L. | Fabaceae | 5 | 0 | 0 |
| 28. | *Bauhinia variegata* L. | Fabaceae | 3 | 3 | 0 |
| 29. | *Altingia excelsa* Noronha | Hamamelidaceae | 7 | 6 | 0 |
| 30. | *Gmelina arborea* Roxb.ex Sm. | Lamiaceae | 1 | 0 | 0 |
| 31. | *Beilschmiedia assamica* Meisn. | Lauraceae | 1 | 0 | 0 |
| 32. | *Cinnamomum bejolghota* (Buch. Ham.) Sweet | Lauraceae | 1 | 0 | 0 |
| 33. | *Phoebe attenuata* (Nees) Nees | Lauraceae | 3 | 0 | 0 |
| 34. | *Phoebe cooperiana* P.C. Kanjilal & Das | Lauraceae | 2 | 0 | 0 |
| 35. | *Duabanga grandiflora* (Roxb. Ex DC.) Walp. | Lythraceae | 11 | 15 | 2 |
| 36. | *Lagerstroemia parviflora* Roxb. | Lythraceae | 2 | 3 | 0 |
| 37. | *Magnolia champaca* (L.) Baill. ex Pierre | Magnoliaceae | 2 | 0 | 0 |
| 38. | *Magnolia hodgsonii* (Hook.f. & Thomson) | Magnoliaceae | 30 | 3 | 0 |
| 39. | *Michelia oblonga* Wall. ex Hook.f. & Thomson | Magnoliaceae | 0 | 1 | 0 |
| 40. | *Bombax Ceiba L.* | Malvaceae | 1 | 0 | 0 |
| 41. | *Pterospermum acerifolium* (L.) Willd. | Malvaceae | 20 | 1 | 2 |
| 42. | [*Sterculia lanceolata* Cav.](http://www.google.com/url?q=http%3A%2F%2Fwww.plantsoftheworldonline.org%2Ftaxon%2Furn%3Alsid%3Aipni.org%3Anames%3A994370-1&sa=D&sntz=1&usg=AOvVaw1nL8yv7HR88gPCVn-IIKJF) | Malvaceae | 0 | 1 | 0 |
| 43. | *Sterculia villosa* Roxb. ex Sm. | Malvaceae | 1 | 0 | 0 |
| 44. | *Sterculia alata* Roxb. | Malvaceae | 4 | 3 | 0 |
| 45. | *Sterculia hamiltonii* (Kuntze) Adelb. | Malvaceae | 2 | 0 | 0 |
| 46. | *Aglaia spectabilis* (Miq) S.S.Jain & Bennet | Meliaceae | 14 | 4 | 0 |
| 47. | *Amoora wallichi* King | Meliaceae | 0 | 1 | 0 |
| 48. | *Chukrasia tabularis* A. Juss | Meliaceae | 1 | 1 | 0 |
| 49. | *Dysolxylum gotadhora* (Buch. Ham.) Mabb. | Meliaceae | 22 | 2 | 1 |
| 50. | *Aglaia sp. Lour.* | Meliaceae  | 2 | 0 | 0 |
| 51. | *Artocarpus chaplasha* Roxb. | Moraceae | 4 | 0 | 0 |
| 52. | *Ficus auriculata* L. | Moraceae | 0 | 1 | 0 |
| 53. | *Ficus Benghalensis* L. | Moraceae | 1 | 0 | 0 |
| 54. | *Ficus religiosa* L. | Moraceae | 1 | 0 | 0 |
| 55. | *Ficus sp*  | Moraceae | 3 | 3 | 0 |
| 56. | *Horsfieldia kingii* (Hook. F.) Warb. | Myristicaceae | 1 | 3 | 0 |
| 57. | *Syzygium spp.* | Myrtaceae | 2 | 9 | 2 |
| 58. | *Chionanthus macrophyllus* (Wall. Ex G. Don) Blume | Oleaceae | 1 | 0 | 0 |
| 59. | *Baccaurea ramiflora* Lour. | Phyllanthaceae | 2 | 0 | 0 |
| 60. | *Bridelia retusa*(L.) A. Juss. | Phyllanthaceae | 1 | 0 | 0 |
| 61. | *Micromelum integerrimum* (Roxb. ex DC) Wight & Arn. ex M.Roem. | Rutaceae | 1 | 0 | 0 |
| 62. | *Meliosma pinnata (Roxb.) Walp. ssp. barbulata (Cufod.) Beus.* | Sabiaceae | 1 | 0 | 0 |
| 63. | *Ailanthus grandis* Prain | Simaroubaceae | 5 | 1 | 0 |
| 64. | *Tetrameles nudiflora* R. Br. | Tetramelaceae | 33 | 4 | 1 |
| 65. | *Elaeocarpus obtusifolius* Merr. | Tiliaceae | 0 | 0 | 1 |
| 66. | *Dendrocnide sinuata* (Blume) Chew | Urticaceae | 5 | 0 | 0 |
| 67. | *Laportea crenulata* Gaud. | Urticaceae | 1 | 0 | 0 |