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Study on Avian Utilization of *Gmelina arborea* in General Hassan Usman Katsina Park, Kaduna, Nigeria

Himma Bakam[1*], Fatima Nura[1], Boniface O. Agbo[1] and Dauda Tanko[2]
1. Department of Biological Sciences, Kaduna State University, Tafawa Balewa Way, P.M.B. 2339, Kaduna, Nigeria
2. Department of Biological Sciences, Federal University, Lokoja, Kogi State, Nigeria

Abstract

A study on the avian utilization of *Gmelina arborea* in General Hassan Katsina Park (Gamji Park) was carried out between 0630hr to 0830hr, from December 2015 to January 2016. Four *G. arborea* trees spaced 100 m apart were identified and each observed from a 50 m distance while recording the bird species, time spent and behavioral activities carried out on the trees. A total of 26 bird species belonging to 18 families were recorded in five height classes of the tree, using focal observation. Bird diversity index was highest (2.50) in the fourth stratum, 16-20 m, and reduced to the second stratum, 6-10 m (2.18). The topmost stratum (21-25 m) recorded the least diversity index value (1.23), other than the 1-5 m height stratum where no bird was recorded. Six bird species that included members of the family: Psittacidae encountered and the Yellow-billed kite (*Milvus migrans*) however, utilized the topmost height. Bird abundance closely followed the same trend. Vinaceous dove (*Streptopelia vinacea*) spent the highest mean time (268 seconds) on the tree perching, closely followed by Piacpiac (*Ptilostomus afer*) (249 seconds). Yellow-billed kite (*Milvus migrans*) spent the least time of 36 seconds. Highest frequencies of bird activity were perching (29.67 %), gleaning (27.25 %), hopping (24.39 %) and preening (19.69 %). Yellow-billed kite and Grey kestrel spend the least time but often seen hovering and scanning in the park. The results indicate predominance of selectiveness over random utilization of *G. arborea* for most bird species observed.

Key words: Bird species, Height class, *Gmelina arborea*, utilization, Kaduna.

1. Introduction

Many factors influence bird diversity and abundance as it relates to their habitat utilization. Previous studies have suggested bird species composition in a habitat to be predicted by trees (Recher, 1969). Different researchers have however reported varying good vegetative indicators for bird species. Airola & Barrett (1985) stated tree species to play the greatest role in bird selectivity whereas MacArthur & MacArthur (1961) stated tree height and density to have the greatest effect. These therefore indicate that birds found in particular habitat will selectively utilize vegetation rather than randomly. Species will also coexist through resource partitioning, including the partition of habitat, food and habitat utilization time (Mittelach, 1984). The variations of habitat utilization and foraging behavior of coexisting species have been considered evolutionary strategies to partition limited resources and to minimize potential interspecific competition (Ishtiaq *et al*., 2010; Zhao, *et al.*, 2013). Variations in habitat characteristics are the main factors affecting habitat utilization (Ribeiro, *et al.,* 2004). As a result, differences may be found in microhabitat utilization and food selection (Davis & Smith, 2001; Vahl *et al.*, 2005; Kober & Bairlein, 2009). Several studies have been reported on how birds utilize vegetations; others reported a single species utilizing heterogeneous plant species. Very few studies have considered how birds utilize single tree species in Nigeria which results can help in understanding how different tree species support faunal species.

In developed countries for instance, fast growing trees are been considered to function in supporting wildlife and at the same time sustaining the economy within a small time frame. This is done to revive the long-term biotic diversity which may have not been adequately preserved as a result of the demand for economically productive land uses, other anthropogenic disturbance and land conversion, especially in established parks and nature reserves (Rotenberg, 2007). Conservation biologists are now examining attributes of tree species to determine which species supports wildlife and make economic sense.

G. arborea (Family: Verbanaceae) is one of the fastest and widely grown deciduous trees of moderate to large size (Cromer *et al.*, 1993), compared to many exotic species grown under the same conditions. It is native to tropical moist forest from India, Burma and Sri Lanka to Southern China. It is widely introduced in Brazil, Gambia, Honduras, Ivory Coast, Malaysia, Malawi and Sierra Leone (Duke, 2002). The plant is grown for several beneficial uses. The US for instance, grows *G. arborea* for several functions such as wood and paper pulp (Rotenberg, 2007). In Nigeria, *G. arborea* is one of the widely grown economic plantation species

(Ademiluyi & Okeke, 1973), providing raw materials for constructions, instruments and paper industry (Duke, 2002), and also for its medicinal properties. It is however also grown around homes, government estates, and recreational parks as a means of creating shade, wind break and replacing already cut-down native species.
Recent conservation studies have also identified the plantation as an alternative land-use practices that may sustain avian biodiversity (Donald, 2004), considering the land changes from human interference. These land uses, sometimes referred to as "countryside habitats" (Daily *et al.,* 2001), may support a considerable fraction of the original avifauna. It is estimated that there are between 700,000 and 1 million ha of *G. arborea* under cultivation in the tropics and subtropics, with at least another 100,000 ha expected to be added by 2020, specifically in Central America and parts of Southeast Asia (Dvorak, 2004).

Although plantations of *G. arborea* exist elsewhere, there has not been an extensive study of the avian community they support (Rotenberg, 2007). Therefore, the question of how this plantation of *G. arborea* provide or support a significant subset of birds that live in Gamji Park becomes important, since it is one of the dominant trees in the park. Understanding this will provide information on the advantages of *G. arborea* in the promotion of ecotourism like birding, and can also help in management practice. To answer this question, we examined how birds use *G. arborea* in Gamji Park and what birds the tree supports.

2. Materials and Methods

2.1 Study Area

General Hassan Katsina Park (Gamji Park) is a recreational park situated in Kaduna North Local Government Area of Kaduna State (10º30´17.28″N, 7º27´10.8″E), northern Nigeria. The park started off as a garden during the colonial rule, occupying an area of about 7, 000 square meters, and rises 586 m above sea level. It is characterised by natural settings of animals (captive and free living) and trees, recreational lawns of well-trimmed grass and ornamental shrubs, mangrove, orchard and dotted small islands from river Kaduna that flows beside it. It is equipped with facilities to accommodate large number of recreational visitors. Many residential buildings can be seen within close vicinity of the amusement and recreational park (Figure 1).

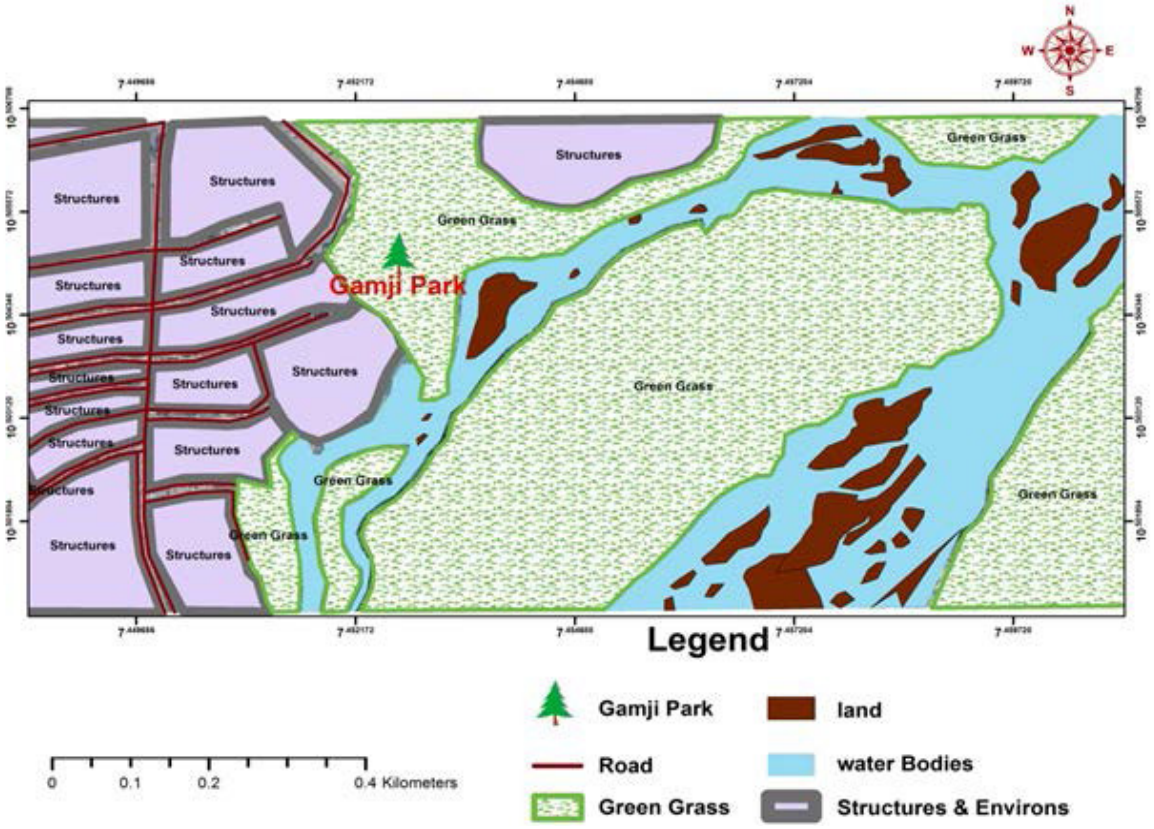

Figure 1. Sketched Map of General Hassan Katsina Recreational Park (Gamji Park) Kaduna

2.2 Focal observation

Four trees of *G. arborea* were identified in the park, spaced 100 m apart. Using a Global Positioning System (GPS) unit (Garmin, eTex 10), the positions of the trees were marked, and measuring poles of 10 m length were placed close to the marked trees in order to estimate height of birds observed in the different foliage strata. Birds higher than the 10 m pole skywards had the foliage height estimated (Jayson & Mathew, 2003). A point with relative cover was chosen 50 m away from each tree such that there was no visual obstruction of bird activities and with less probability of bird scare but far enough to observe bird behavior, from where focal observation were made following the focal and scan sampling techniques, using a pair of Binocular (Olivon 8×42) (Yilangai *et al.*, 2014). Identification of bird species was made with the aid of a Bird Guide, "Birds of Western Africa" by Borrow and Demey (2004). Observations were carried out from 0630hr to 0930hr daily with each tree observed and alternated systematically within intervals of 30 minutes. The duration of time spend was recorded by noting bird arrival and departure time on *G. arborea*, flock size, tree height, as well as the activities carried out by each bird were also recorded. The data for each tree was pooled separately and classified into five groups of the tree heights: 0-5 m, 6-10 m, 11-15 m, 16-20 m, 21-25 m. Birds at the ground level (0 m) were however not considered in the data in order not to confound the results obtained in the study, since birds in this level may be other than *G. arborea*, utilize other plants and plant products, or insects. The observations lasted from December 2015 to January 2016; part of the period was when the tree was beginning to flower.

2.3 Data analysis

The data was entered into Microsoft excel 2010, and analyzed using R statistical package (Version 2.12.0). Means of tree height and the duration of stay by birds on each tree were computed. Shannon Weiner diversity index as well as Menhinick's species richness index was used to calculate bird species diversity and richness respectively. Species diversity *H'*, is a combination of number of species and their relative abundance in a community (Begon and Harper, 2002) and calculated as, Shannon Weiner diversity index,

$$H' = -\sum_{i=1}^{s} pi \ln pi \qquad (1)$$

where s is the number of species and *pi* is the proportional of the total number of individuals consisting of the *ith* species. Whereas species richness is a measure of the number of species found in a sample. Thus, it is the number of species divided by the square root of the number of individuals in the sample and computed as:

Menhinick's species richness index, $D = \frac{s}{\sqrt{N}}$ (2)

where *s* equals the number of different species represented in your sample, and N equals the total number of individual organisms in your sample.

3. Results

3.1 Species richness and composition

A total of 25 bird species belonging to 18 families were recorded in five height classes. Four species of birds used all the height classes of *G. arborea* except for height 0-5 m where no bird was recorded. These species can be termed as generalists; prominent among them were the Bearded barbet (*Lybius dubius*), Rose-ringed parakeet (*Psittacula krameri*), Pied crow (*Corvus albus*) and Scarlet-chested sunbird (*Chalcomitra rubescens*) (Table 1).

3.2 Abundance and diversity

The number of birds varied along the different strata of the trees, with the highest number of birds observed in the third stratum (618). This was closely followed by the next upper stratum (16-20 m) with 410 birds. The second stratum was observed to have fewer numbers of birds with the top canopy having the least number. No bird was however seen utilizing the first stratum (1-5 m) (Table 1). Bird diversity index was highest in the fourth stratum (2.50), and declined downwards to the first stratum (0.00). The topmost canopy also had a lower index of 1.23 (Table 1).

3.3 Species time budget

Bird species did not spend the same time on *G. arborea*. Vinaceous dove spent the highest time with a mean time spent of 268 seconds, closely followed by Piacpiac with 249 seconds. Yellow-billed kite had the least time spent (36 seconds) followed by the Grey Kestrel (60 seconds), both of which are birds of prey. Most of the bird species spent an average time of between 60 to 210 seconds utilizing *G. arborea* (Figure 2).

3.4 Habitat utilization

During the study, 8 behavioral activities were observed. Highest frequencies of bird behavioral activities were observed on birds gleaning trunk (27.25 %), hopping (24.39 %) and preening (19.69 %). Least frequency of 0.86 % was observed on birds that were feeding on nectar, noticeable with the sunbirds. Neither courtship behavior nor nesting process was observed during the study (Figure 3).

Table 1. Diversity and abundance of birds observed on different tree strata in Gamji Park.

Tree strata (m)	Number of Birds (Abundance)	Menhinicks species richness (*D*)	Shannon Wiener Diversity Index (*H'*)
1-5	0	0.00	0.00
6-10	307	1.03	2.18
11-15	618	0.93	2.20
16-20	410	0.99	2.50
21-25	26	1.18	1.23

Table. 2. Bird species encountered in different tree heights of *G. arborea* in Kofar Gamji.

Common Names	Scientific Names	Height strata				
		I	II	III	IV	V
Yellow-billed Kite	*Milvus migrans*				✓	✓
Black-shouldered Kite	*Elanus caeruleus*			✓	✓	
Common Kestrel	*Falco tinnunculus*			✓	✓	
Grey Kestrel	*Falco ardosiaceus*			✓		
Laughing Dove	*Streptopelia senegalensis*		✓	✓	✓	
Red-eye Dove	*Stretopelia semitorquata*		✓	✓	✓	
Vinaceous Dove	*Streptopelia vinacea*		✓	✓	✓	
Senegal Parrot	*Poicephalus senegalus*			✓	✓	✓
Rose-ring Parakeet	*Psittacula krameri*		✓	✓	✓	✓
Western- Grey Plantain-eater	*Crinifer piscator*				✓	
Green Wood-hoopoe	*Phoeniculus purpureus*		✓	✓	✓	
Black Wood-hoopoe	*Rhinopomastus aterrimus*		✓		✓	
Bearded Barbet	*Lybius dubius*		✓	✓	✓	✓
Grey Woodpecker	*Dendropicos goertae*		✓	✓		
Common Bulbul	*Pycnonotus barbatus*		✓	✓	✓	
Brown Babbler	*Turdoides plebejus*		✓	✓	✓	

Yellow-billed Shrike	*Corvinella corvina*			✓		
Yellow-crowned Gonolek	*Laniarius barbarus*			✓		
Scarlet-chested Sunbird	*Chalcomitra senegalensis*		✓	✓	✓	✓
Forked-tailed Drongo	*Dicrurus adsimilis*		✓	✓	✓	
Pied Crow	*Corvus albus*		✓	✓	✓	✓
Piapiac	*Ptilostomus afer*		✓	✓	✓	
Purple Glossy Starling	*Lamprotornis purpureus*		✓	✓		
Long-tailed Glossy Starling	*Lamprotornis caudatus*		✓	✓	✓	
Village Weaver	*Ploceus cucullatus*		✓	✓	✓	
Red-billed Firefinch	*Lagonosticta senegala*		✓	✓		

Height strata: I = 1-5 m, II = 6-10 m, III = 11-15 m, IV = 16-20 m, V = 21-25 m

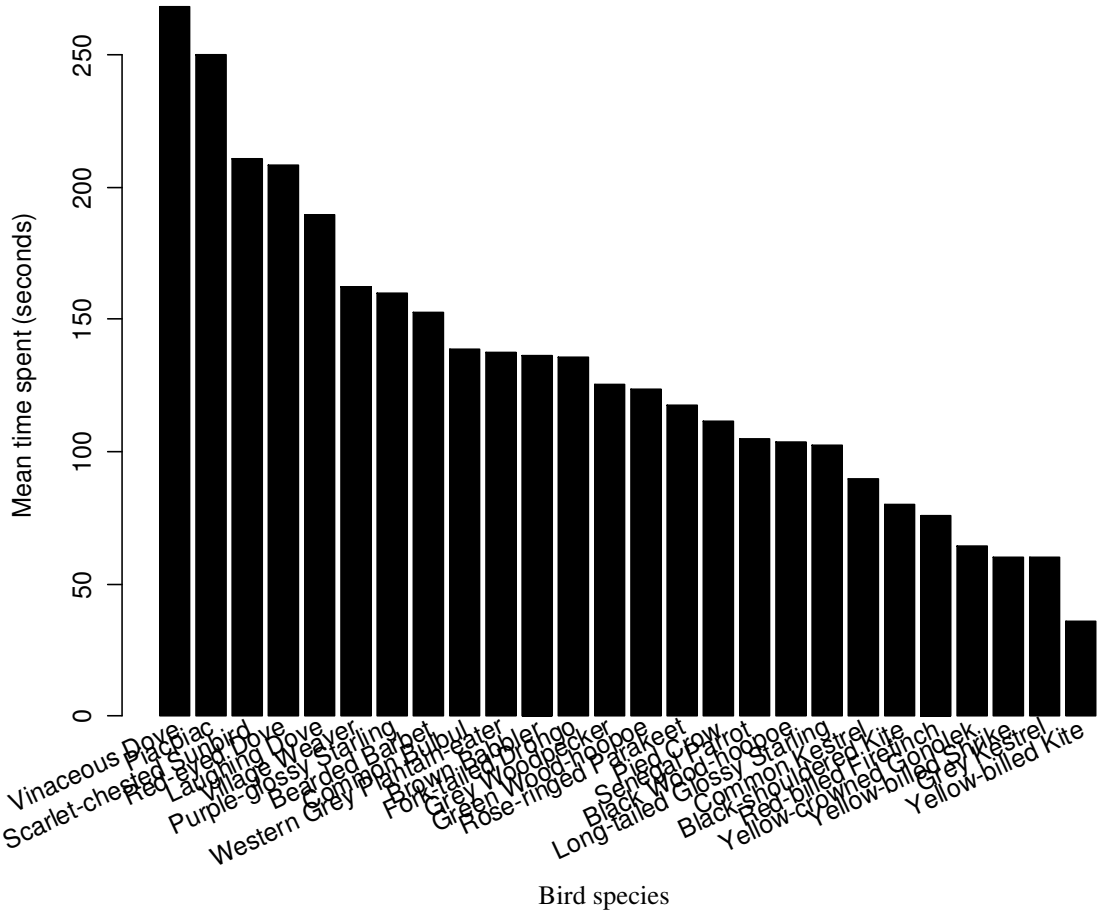

Figure 2. Bird Species and Mean Time Spent on *Gmelina arborea*

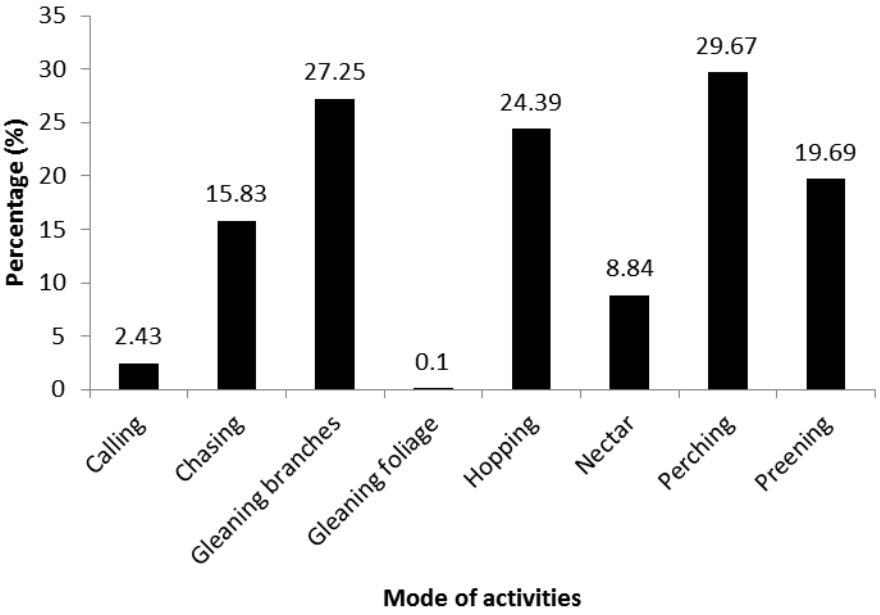

Figure 3. Behavioral activities carried out by birds utilizing *G. arborea* in Gamji Park

4. Discussion

Information on the utilization of foliage by birds is significant for park management and nature reserve conservation. It has been an established fact that birds utilize their habitats differently (Sandunika *et al*., 2013), depending on the available resources and how the resources are partitioned. As there are differences in the transmittance of photo synthetically active radiation (PAR) along the different layers of canopy (Jayson and Mathew, 2003), parameters such as microclimate, food availability and food substrate are bound to change thereby varying the ecological conditions crucial for birds This can therefore affect the way birds are distributed along different strata of foliage.

Rotenberg (2007) reported *Gmelina* habitats to support considerable number of bird species than several other exotic, tropical monocultures, however pure stands of *G. arborea* did not have attractive capacity. Out of the 26 bird species observed to be utilizing *G. arborea* during this study, four species utilized the topmost four tree strata leaving the first stratum (0-5 m). No bird was however observed utilizing the lowest strata (1-5 m) because the height was mainly the trunk as such birds were utilizing the canopy for functions such as shade, nectar feeding, resting, and exhibiting other behavioral activities essential for their survival. Birds were observed in the ground level (0 m) to be utilizing grasses, seeds, insects, and other plant species other than *G. arborea*, obvious were the Piacpiac which moved in flock while hopping and feeding on the ground. Members of the family Columbidae were also observed to either utilize two or three of the tree strata. These species can be termed generalists. Number of individuals and diversity indices values indicate that the middle canopy is most utilized by the birds than the bottom or top canopy. Although the study centered on *G. arborea*, the result appear to coincide with the observations made by Jayson and Mathew (2003) in their study of vertical stratification of tropical forest birds and its relation to foliage in Western Ghats of India. They however stated species richness and diversity to indicate bird preference for middle canopy

Mean visit lengths in this study (36 – 268 sec, or 0.6 – 4.5 min) were similar to visit lengths of fruit-eating birds in plants (5.5 - 11.7 min; Wheelwright, 1991), visit lengths by New Guinean passerines (4.5 – 12.5 min; Pratt & Stiles 1983) and within the range of visit lengths of birds of neotropical fig (1.9 – 19.7 min; Bronstein & Hoffman, 1987) though very different plant species were involved. Predation risks and diet (Pratt & Stiles, 1983; Silva *et al.*, 2008) may have suggested the variation in time spent by bird species on the tree. The result for the two species, Vinaceous dove and Piacpiac that had highest mean visit lengths on the tree in its simplest form appear to agree with Howe's (1979) model who predicts that larger birds, which were presumably safer from predators, should spend more time than smaller birds. This was however not the case with the Scarlet-chested

sunbird whose time spent closely followed Piacpiac and higher than other larger birds. This result may have been confounded by differences in feeding mode (Santana & Milligan, 1984) because the tree had just started flowering. Three granivorous species consecutively spent higher mean time subsequent to the sunbird. Their slow metabolic rates during digestion and relative larger sizes may have also suggested their longer time spent in *G. arborea*. The Yellow-billed kite and Grey Kestrel, both of which are birds of prey spent least time, all of which were sighted at the top canopy. Since they are large birds and predators, scaring other birds from the top canopy will reduce their feeding success, likely suggesting their time spent on the tree, and their hovering and scanning behavior around the park.

Birds utilized *G. arborea* for several reasons essential for their survival. Five different behavioral modes were observed on birds utilizing *G. arborea* during this study, of which perching was the most common that accounted for 29.67 % of the total observations, followed by gleaning of branches, then hopping. These higher frequencies may be a resting strategy after birds have dart down to feed or are bark from utilizing other foliage which may have more competing number of birds.

5. Conclusion

This study suggests bird species to exhibit different behaviors and selective utilization of *G. arborea*. The results also suggest that *G. arborea* tree other than providing food for the birds; also serve as a perching substrate for birds where they exhibit functional behavioral activities necessary for their survival. Further research is however important to look at how birds utilize the tree within different seasons. It is also important to further investigate on other tree species to determine how they attract bird species and understand how parks managed with increased habitat heterogeneity could support more diversity of birds.

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Appendix I: List of birds observed utilizing *Gmelina arborea* in Gamji Park.

Family name	Common name	Scientific name	Number observed
Accipitridae	Yellow-billed Kite	*Milvus migrans*	2
	Black-shouldered Kite	*Elanus caeruleus*	2
Falconidae	Common Kestrel	*Falco tinnunculus*	4
	Grey Kestrel	*Falco ardosiaceus*	1
Columbidae	Laughing Dove	*Streptopelia senegalensis*	90
	Red-eye Dove	*Stretopelia semitorquata*	57
	Vinaceous Dove	*Streptopelia vinacea*	9
Psittacidae	Senegal Parrot	*Poicephalus senegalus*	14
	Rose-ring Parakeet	*Psittacula krameri*	18
Musophagidae	Western Grey Plantain-eater	*Crinifer piscator*	4
Phoeniculidae	Green Wood-hoopoe	*Phoeniculus purpureus*	13
	Black Wood-hoopoe	*Rhinopomastus aterrimus*	4
Capitonidae	Bearded Barbet	*Lybius dubius*	40
Picidae	Grey Woodpecker	*Dendropicos goertae*	17
Pycnonotidae	Common Bulbul	*Pycnonotus barbatus*	82
Timaliidae	Brown Babbler	*Turdoides plebejus*	19
Laniidae	Yellow-billed Shrike	*Corvinella corvina*	1
Malaconotidae	Yellow-crowned Gonolek	*Laniarius barbarus*	2
Nectariniidae	Scarlet chested Sunbird	*Chalcomitra senegalensis*	100
Dicruridae	Forked-tailed Drongo	*Dicrurus adsimilis*	10
Corvidae	Pied Crow	*Corvus albus*	44
	Piapiac	*Ptilostomus afer*	123
Sturnidae	Purple Glossy Starling	*Lamprotornis purpureus*	6
	Long-tailed Glossy Starling	*Lamprotornis caudatus*	8
Ploceidae	Village Weaver	*Ploceus cucullatus*	8
Estrildidae	Red-billed Firefinch	*Lagonosticta senegala*	5