Pakistan J. Zool., vol. 50(1), pp 329-338, 2018. **DOI**: http://dx.doi.org/10.17582/journal.pjz/2018.50.1.329.338

Nesting Use of Tree Species by Avifauna Inhabiting Pabbi Range Forest, Kharian, Punjab, Pakistan

Tariq Mahmood*[1], Syed Wasif Ahmed Shah[1], Muhammad Rais[1], Hira Fatima[1], Faraz Akrim[1] and Muhammad Sajid Nadeem[2]

[1]*Department of Wildlife Management, PMAS-Arid Agriculture University Rawalpindi 46300, Pakistan*

[2]*Department of Zoology, PMAS-Arid Agriculture University Rawalpindi 46300, Pakistan.*

ABSTRACT

Nesting is a common phenomenon in reproductive behavior of birds that plays an important role during their different life stages. Nest composition and location are important factors in studying utility of plant material by avifauna. The current study investigated nesting use of tree species by avifauna at Pabbi Range Forest Kharian (32.811°N and 73.865°E), District Gujrat, from September 2013 to June 2015. Data were collected from five selected sampling sites by searching and identifying nests of different bird species in various vegetation types and observing birds on the nest. The nests were monitored for breeding activity of the particular bird species through clutch size, incubation period, and hatching success. Sixty-two active nests of various bird species were recorded; common myna *Acredotheris tristis*, house crow *Corvus splendens*, Indian robin *Saxicoloides fulicatus* and black drongo *Dicrurus macrocerus* preferred Kikar *Acacia nilotica* and *Eucalyptus camaldulensis* for nesting purpose while black kite *Milvus migrans* utilized semal tree *Bombax ceiba*. The weaver bird *Ploceus philippinus* also utilized only *Acacia nilotica* for nesting. The common crow, common myna, black kite, black drongo, red turtle dove *Streptopelia tranquebarica* and Indian robin *Saxicoloides fulicatus* successfully bred in particular nests whereas red wattled lapwing *Vanellus vanellus*, pigeon *Columba livia*, parrot *Psittacula* sp. and kingfisher *Halcyon* sp. did not show any evidence of nesting or breeding.

Article Information
Received 26 July 2017
Revised 30 August 2017
Accepted 13 November 2017
Available online 16 January 2018

Authors' Contribution
TM and SWAS designed the study. SWAS, HF and FA collected the data from the field, TM, MR, MSN and SWAH analyzed the data. TM drafted the manuscript.

Key words
Avifauna, nesting, plants, Pabbi, Pakistan.

INTRODUCTION

Nesting is a common phenomenon in reproductive behavior of birds. Nests play very important role in different stages of life of birds including reproduction, protection, environmental measures and survival of the bird. Relation between a bird and tree/plant species is considered a major aspect of wildlife and biodiversity that makes nesting phenomenon a vital factor while studying the life of birds (Dial, 2003). When a bird constructs a nest, several factors are brought into consideration; the most important being minimizing the risk of predation. In order to avoid predation, the nest should possess all those primary as well as secondary qualities necessary for bird survival yet it has to be almost inaccessible to the potential predators. In doing so the nest may be hidden or camouflaged. Nest also acts as a temperature insulator for eggs thereby aiding the young ones. Increased pathogenic and parasitic pressure is faced by passerine birds which reuse nesting site, hence during the process of nesting they are likely to use fresh leaves and grass stems (Hartman and Oring, 2003).

Nest composition and location are important factors in studying the utility of plant material used by avifauna. Microclimatic conditions inside the nest are also very important for birds whether embryonic stage, nestling stage or for adults. However, nest constructed at higher altitude makes it difficult to sustain energy because of high metabolism and low temperature, particularly at night (Calder, 1973). Birds construct different types of nests and utilize them for different purposes. Cavity nests found in tree stems or cacti are used by owls, woodpeckers and some waterfowl. The primary nesters build their own cavities or nests whereas secondary nesters occupy previously abandoned nests and cavities which are sometimes formed by natural processes (Clayton and Moore, 1997).

Nest type varies because of its shape and location. A "Platform" nest may be constructed on a tree, sometimes on the ground, at the top of the rooted vegetation or debris in shallow water as is seen in Western Grebe *Aechmophorus occidentalis* nest. "Cup-shaped" nests are commonly

* Corresponding author: tariqjanjua75@uaar.edu.pk
0030-9923/2018/0001-0329 $ 9.00/0

observed in Pothwar region and central Punjab (Pakistan) although material used in the nest may vary as the location changes (Strayer *et al*., 2006).

Nests having the most complicated structure in terms of construction and shape are passerine woven nests of orpendolas (Genus *Psarocolius*) and baya weaver (Genus *Ploceus*) . They build a complex woven nest that is chambered from inside. In the initial stage the nest has two openings with overall elliptical shape. Later on, when bird fills the chamber walls with mud, the second opening is closed that becomes a pouch where eggs are laid. The remaining opening is further constructed downwards giving a narrow tube like shape that serves as both entry and exit point for the bird (Kartesz and Meacham, 1999).

Studying tree/plant nesting use by birds is very important because it is directly related to wildlife environment. The important plant species used for nesting include not only protection of wildlife but their conservation along with maintaining a balance between flora and fauna that plays an important role in succession of vegetation in that area regardless of its type whether a rangeland, forest or marine habitat. In Pakistan, very little work has been done on the nesting use of plant species by various avifauna, however, some other aspects of a few bird species were focused scantily in recent past as mentioned Mahmood *et al.* (2012) and Hussain *et al.* (2016). Almost no baseline data exist on ecological nesting importance, function of plants in nesting, protection of important species of avifauna as well as behavioral aspects of birds regarding nesting and nesting material. The current study was, therefore, designed to gather information on how nesting type and shape varies from bird to bird and nesting utility of certain plant species and their function regarding bird's necessities for survival and reproduction at "Pabbi Range forest" Kharian, in the province of Punjab. The main objectives of the study included identification of various tree/plant species used by avifauna for nesting purpose and the bird species (avifauna) using different plant species for nesting purposes.

MATERIALS AND METHODS

Study area

The study was conducted at the "Pabbi Range" Forest (32.811°N and 73.865°E), Kharian, Gujrat District, Pakistan (Fig. 1), that covers an area of approximately 15,732 ha with an elevation of about 280 meters above sea level. It was declared as "Reserved Forest" by the forest department Punjab although there is some overlap of territorial and area jurisdiction between the forest department and the Military Cantonment Board. Topography of the area is undulating but land is fertile, partially saline with water availability in the form of irrigation system of water canal from River Jhelum. Moreover, the area also falls in the Monsoon impact zone that results in two rainy seasons, first in March and then again July each year. The area also comprises of kikar, shisham, *Eucalyptus* and poplar plantation. Most of the area is covered with grasses and shrubs while trees are patchy due to rough topography and fluctuation in ground water table. Strip of the canal "upper Jhelum" falls within the area where vegetation is luxuriant due to sufficient water availability. Natural vegetation is sparse in the study area, the dominant tree and shrub species include *Acacia nilotica*, *Dalbergia sissoo*,

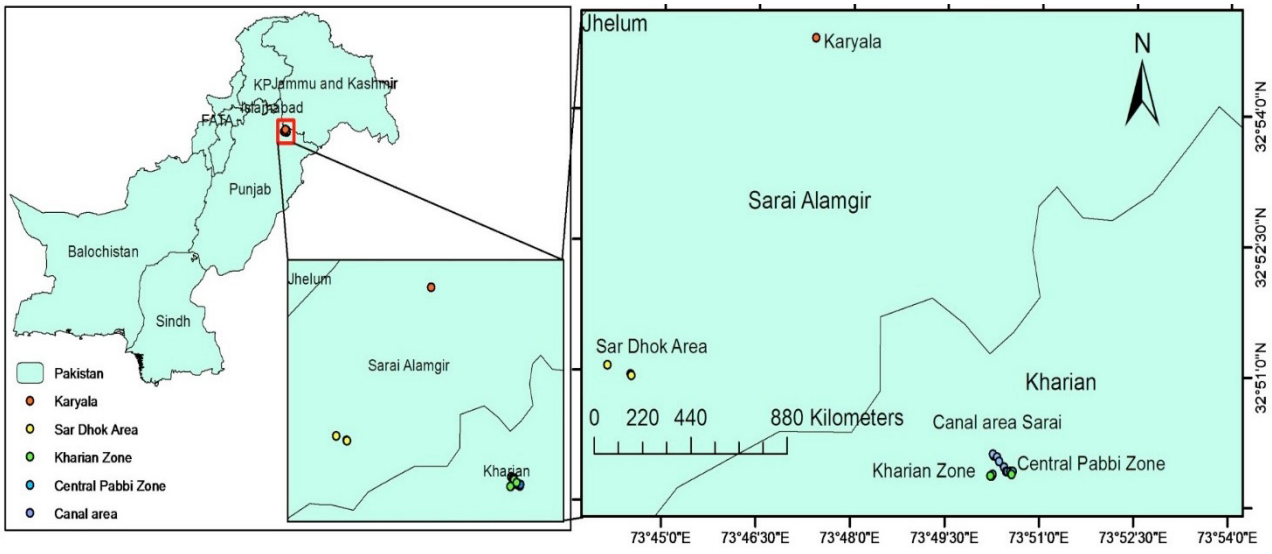

Fig. 1. A GIS-based map showing location of the "Pabbi Range forest" Kharian and five selected sampling sites.

Acacia arabica, *Tamarix aphylla* and *Eucalyptus camaldulensis*. Grasses and herbs reported from the area include *Cynodon dactylon*, *Amaranthum viridis, Digitaria ciliaris, Conyza species, Achyranthes species, Alhajai maurorum, Cyperus rotundus, Setaria verticillata, Saccharum spontaneum* and *Typha elephantina.*

Study design

Field visits to the study area were made fortnightly from October 2013 to June 2015 for data collection. After reconnaissance survey, five different sampling sites were selected viz., Canal area (Sarai Alamgir), Central Pabbi Zone, Kharian Zone, Sar Dhok Area and Karyala (Table I). The particular sampling sites were selected on the basis of occurrence of different bird species in the area and their nests. The site-I covered a total area of approximately 500 m^2 of the forest Block of Sarai Alamgir, having sufficient water with luxuriant vegetation. The site-II (Central Pabbi) was located in Forest Block Kharian and comprised an area of 344 m^2 having patchy vegetation. The site-III included a 500 m^2 area in Kharian zone and included grasses and shrubs. The sampling site-IV covered an area of 540 m^2 in Sar Dhoke area having grasses mostly, while Site-V (Karyala) covered an area of 300 m^2 with agricultural land. Geographical coordinates of sampling sites were recorded as well as the major habitat features and plant species at each site. The plant species including trees, shrubs and herbs at all selected sites were searched for recording nests of different bird species. Similarly, the sampling sites were also searched for enlisting different bird species, especially those building nests in the vegetation.

The area of each sampling site was variable ranging between 300 m^2 to 540 m^2. The Rangeland forest was found in patches mostly having natural vegetation, agricultural land, tree plantations and villages. All sampling sites were surveyed before selection to confirm the presence or absence of avifauna and their nests. Areas where water was sufficiently available (as underground water) mostly near the canal had lush green vegetation and diverse flora. Vegetation was dense, thus providing roosting and nesting sites for avifauna in the area.

Methodology

Selected sampling sites were thoroughly surveyed for recording the presence of nests on vegetation species as well as the bird species using the nest. The particular nests were located, and identified, and both the nests and the bird species using the nests were photographed. Location of the nest on tree species was recorded each time when a nest was discovered. All essential information such as nest shape, type, diameter and materials used in nesting, was also recorded.

Bird species were observed using binocular (Olympus 10 x 50 mm DPS I), identified with the help of field guide (Grimmett *et al*., 2007) and the photographs taken in the field, preferably in close vicinity of their nests. Nests were searched, located and studied on the basis of their shape, height and their coordinates recorded using GPS device (Garmin etrex Vista). Height of the nest in relation to tree height and ground level was measured by tree stick and Abney's level. Trees on which the nests were constructed, were identified and their total height was recorded along with their location and elevation from the sea level. The plant materials used for nest construction by the bird species were identified with the help of field guides and by getting help from plant taxonomists.

After identification of the nests and the bird species, the nests were later on focused for monitoring the breeding activity of the particular bird species utilizing the nest. The breeding activity of each bird species was monitored by recording the clutch size in the particular nest, incubation period, and the hatching success.

Statistical analysis

The data were analyzed statistically using various parameters including tree species used for nesting, avifauna using the nests and location of the nest (sampling site). One way-Analysis of Variance (ANOVA) was applied to check the significance of the mean difference of various groups of the data. To check the dependency as well as correlation between the parameters FACTORIAL DESIGN was applied using STATS 8.1.

Table I.- Details about five selected sampling sites at the Pabbi Range forest Kharian, district Gujrat, Pakistan

Site No.	Site name	Area ($m^{2)}$	Geographical Coordinates	Forest Block	Major Habitat Features
1	Canal area Sarai Alamgir	500	32º49′53″N , 73º50′29″E	Sarai Alamgir	Sufficient water with luxuriant vegetation
2	Central Pabbi Zone	344	32º49′50″N , 73º50′15″E	Kharian	Patchy vegetation
3	Kharian Zone	500	32º51′03″N , 73º44′08″E	Kharian	Grasslands with shrubs
4	Sar Dhok Area	540	32º54′51″N , 73º47′24″E	Rajrin	Grassland
5	Karyala	300	32º57′51″N , 73º20′24″E	Kharian	Agricultural land

RESULTS

Sixty-two (62) nests of seven different bird species were recorded at five sampling sites in the study area (Table II), maximum numbers of nests being found at sampling site-IV. Similarly, maximum numbers of nests (n = 30) were recorded for weaver bird (but only at one sampling site), followed by common crow (N = 15), common myna (N= 6), among others black drongo showed 4, black kite and red turtle dove 3 nests each, while Indian robin showed only one nest (Table II).

Birds nesting

Common myna

Six nests of common myna *Acridotheres tristis* were recorded at two sites out of five (Tables II, III; Fig.2 A); the preferred tree species for nesting included *Acacia nilotica* (n = 4) and *Eucalyptus camaldulensis* (n = 2). Average nest height was 7.53 ± 0.61m while mean nest diameter measured 23.65 ± 0.61cm. The nests of the common myna were round in shape and constructed using dry tree leaves, grass husks or stems.

Common crow

The nesting of common crow *Corvus splendens* was recorded at all five selected sites (n = 15), with maximum number of nests at Site-V (Tables II and IV; Fig. 2B). The preferred tree species for nesting included *Acacia nilotica* (at sites-I, II, III and IV) having three nests on different trees, *Eucalyptus camaldulensis* (at site-II) having one nest while all eleven nests at site-V were built on *Populus deltoids*. Average nest height was 7.12 ± 0.36 m and average nest diameter was measured to be 21.72 ± 0.91cm. The nests were composed of mainly dry branches of thorny trees with leaves inside.

Black drongo

Four nests of black drongo *Dicrurus macrocercus* were recorded at sites-II and III (Tables II and V; Fig. 2C); three of those were measured for their characteristics. Two tree species preferred for nesting included *Eucalyptus camaldulensis* (n=2) and *Acacia nilotica* (n=1); the average height of nest being 10.14 ± 0.90 m**.** Those built on *Eucalyptus* were round in shape while the one on *Acacia* tree was cup-shaped; average nest diameter being 21.43 ± 0.64 cm. Nest composition included dry tree leaves, grass husks and roots.

Black kite

Three nests of black kite *Milvus migrans* were recorded at three different sites (Tables II and V; Fig. 2D), *this bird species preferred semal tree Bombax ceiba for being tall, for nesting purpose. Average nest height was* 10.14 ± 0.90 m while average nest diameter was measured to be 27.4 ± 0.28 cm. All nests were round in shape with rough edges and composed of dry branches of thorny trees with leaves inside.

Red turtle dove

Three nests of the red turtle dove *Streptopelia tranquebarica* were recorded at only one site (IV); all built on *Acacia nilotica* (Tables II and VI). Average nest height and diameter were 5.36 ± 1.43 m and 21.96± 0.29 cm, respectively. Round in shape, all three nests were composed of grass stems, roots and small shrub branches.

Indian robin

Only one nest of Indian robin *Saxicoloides fulicatus* was recorded (at site-I) and nowhere else (Tables II and IV; Fig. 2F). Built on *Eucalyptus camaldulensis*, the average nest height and diameter being 5.36 ± 0.00 and 22.4 ± 0.00 cm, respectively and composed of tree leaves with grass leaves and roots.

Table II.- Distribution and prevalence of Avifauna nests at five different sampling sites in the Pabbi Range forest Kharian, Pakistan.

Nest Records	species name	Sampling sites					Total
		I	II	III	IV	V	
Common myna	*Acridotheres tristis*	3	-	3	-	-	6
Common crow	*Corvus splendens*	1	1	1	1	11	15
Indian robin	*Saxicoloides fulicatus*	1	-	-	-	-	1
Black kite	*Milvus migrans*	-	1	1	1	-	3
Black drongo	*Dicrurus macrocercus*	-	3	1	-	-	4
Red turtle dove	*Streptopelia tranquebarica*	-	-	-	3	-	3
Weaver bird	*Ploceus philippinus*	-	-	-	30	-	30
Total		5	5	6	35	11	62

Table III.- Vegetation preference of common myna *Acridotheres tristis* for nesting at Pabbi Range Kharian.

Sampling site	Vegetation species used for nesting	Height of tree (m)	Height of nest on tree (m) from ground level	Nest diameter (cm)	Nest shape	Nest composition
I	*Acacia nilotica*	9.75	8.91	25.4	Round	Dry tree leaves, grass husks
I	*Eucalyptus camaldulensis*	8.83	8.01	24.4	Round	Dry tree leaves, grass husks
I	*Eucalyptus camaldulensis*	8.91	7.33	24.8	Round	Dry tree leaves, grass husks
III	*Acacia nilotica*	5.48	5.10	22.4	Round	Tree branches, leaves and grass stems
III	*Acacia nilotica*	6.14	6.74	21.5	Round	Tree branches, leaves and grass stems
III	*Acacia nilotica*	10.35	9.10	23.4	Round	Tree branches, leaves and grass stems
Mean ± SE		8.24 ± 0.80	7.53 ± 0.61	23.65 ± 0.61		

Table IV.- Vegetation preference of common crow Corvus splendens for nesting at Pabbi Range Kharian.

Sampling site	Vegetation species used for nesting	Height of tree (m)	Height of nest on tree (m) from ground level	Nest diameter (cm)	Nest shape	Nest composition
I	*Acacia nilotica*	9.14	8.37	28.1	Round with rough edges	Dry branches of thorny trees with leaves inside
II	*Eucalyptus camaldulensis*	11.2	10.1	26.5	Round with rough edges	Dry branches of thorny trees with leaves inside
II	*Acacia nilotica*	8.83	8.00	23.2	Round with rough edges	Dry branches of thorny trees with leaves inside
III	*Acacia nilotica*	6.70	6.23	24.5	Round with rough edges	Dry tree branches and grass stems
IV	*Acacia nilotica*	8.53	8.14	25.1	Round with rough edges	Dry branches of thorny trees with leaves inside
V	*Populus deltoides*	6.32	6.01	20.1	Round with rough edges	Tree branches, shrubs, branches
V	*Populus deltoides*	7.13	5.21	20.2	Round with rough edges	Tree branches, shrubs, branches
V	*Populus deltoides*	6.97	5.99	19.6	Round with rough edges	Tree branches shrubs, branches
V	*Populus deltoides*	7.55	6.01	18.9	Round with rough edges	Tree branches , shrubs, branches
V	*Populus deltoides*	7.33	6.67	18.9	Round with rough edges	Tree branches, shrubs, branches
V	*Populus deltoides*	8.11	7.34	19.8	Round with rough edges	Tree branches, shrubs, branches
V	*Populus deltoides*	8.21	7.67	18.6	Round with rough edges	Tree branches, shrubs, branches
V	*Populus deltoides*	7.90	6.89	18.9	Round with rough edges	Tree branches, shrubs, branches
		7.99± 0.35	7.12 ± 0.36	21.72 ± 0.91		

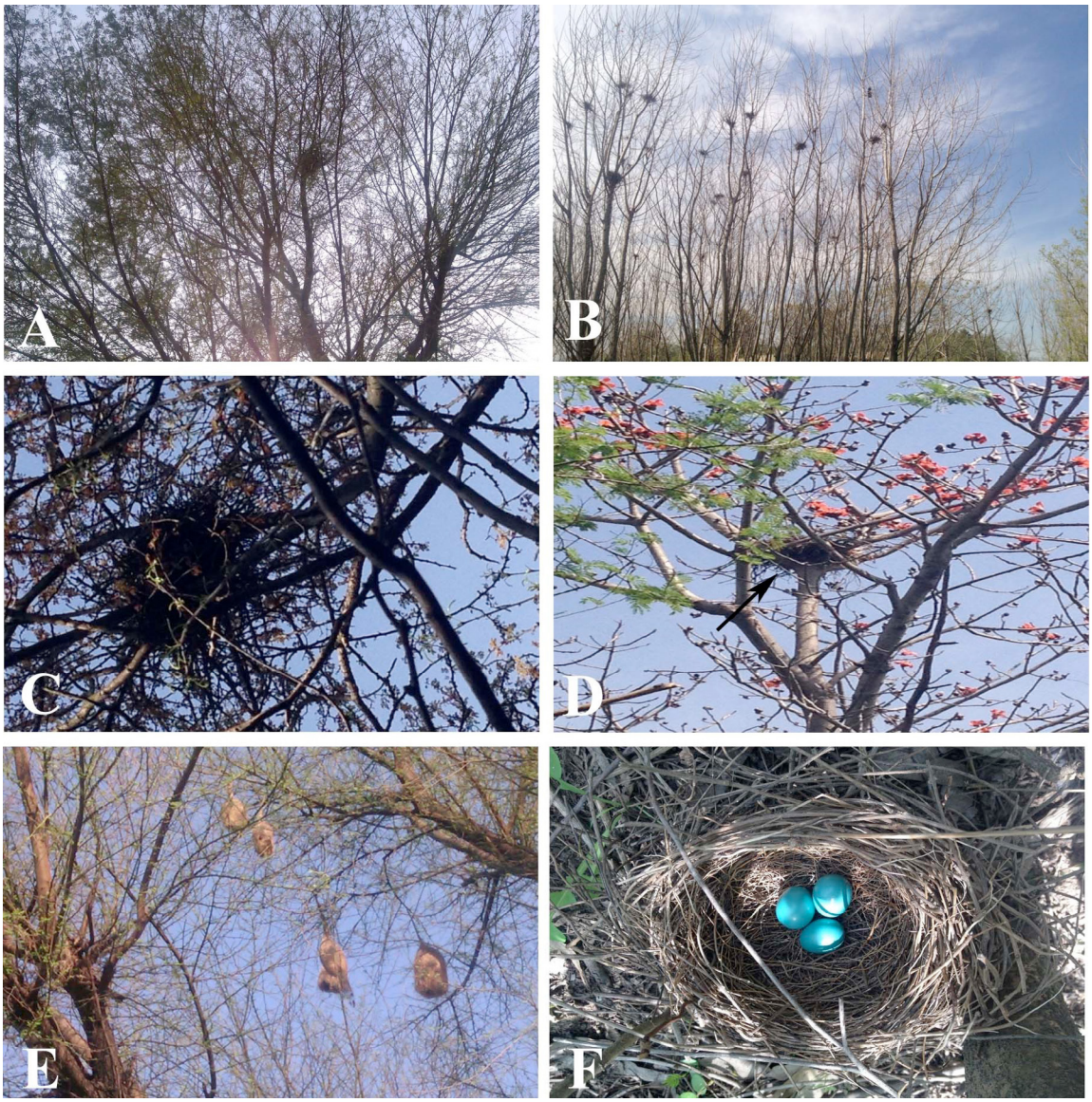

Fig. 2. Field photographs of nests of bird species at Pabbi range Kharian. A, Common myna built nest on *Acacia nilotica* at site-I; B, Colony of common crow nests on *Populus deltoids*; C, Black drongo nest on *Acacia nilotica* at site-III; D, Black kite on *Bombax ceiba* (at site-II; E, Weaver bird on *Acacia nilotica* at site-IV; F, Indian robin having beautiful color eggs on *Eucalyptus* tree at site-I.

Weaver bird

A colony of n = 30 nests of weaver Bird *Ploceus philippinus* was recorded at *Acacia nilotica* at site-IV (Tables II and VI; Fig. 2E); all nests being pendulum shaped and composed of grass leaves and branches, showed no evidence of breeding later on, since no eggs were found in these nests.

Among all bird species in the study area, average nest height of black kite nests was the maximum (10.14 m), followed by weaver bird, common myna and common crow while the lowest nest height (5.36 m) recorded was that of red turtle dove nest (Fig. 3).

Statistical analysis

Data were analyzed statistically by using One-way Analysis of Variance (ANOVA). Results showed no site-wise relation in terms of birds and trees. At all sampling sites, highest mean value was found for house crow (Table VII) which completely dominated the study Site-V and in case of trees it was *Acacia nilotica* which was mostly preferred

Table V.- Vegetation preference of black drongo (*Dicrurus macrocercus*) and black kite (*Milvus migrans*) for nesting at Pabbi Range Kharian.

Bird species	Sampling site	Vegetation species used for nesting	Height of tree (m)	Height of nest on tree (m) from ground level	Nest diameter (cm)	Nest shape	Nest composition
Black drongo	II	*Eucalyptus camaldulensis*	6.04	5.75	22.4	Round	Dry tree leaves, grass husks and roots
	II	*Eucalyptus camaldulensis*	7.62	6.54	21.7	Round	Dry tree leaves, grass stem and roots
	III	*Acacia nilotica*	8.33	7.81	20.2	Cup	Grass stems, tree branches and leaves
	Mean ± SE		7.33 ± 0.67	6.7 ± 0.60	21.43 ± 0.64		
Black kite	II	*Bombax ceiba*	13.1	11.3	27.4	Round with rough edges	Dry tree branches grass stem
	III	*Bombax ceiba*	12.90	10.76	26.9	Round with rough edges	Dry branches of thorny trees with leaves inside
	IV	*Bombax ceiba*	8.94	8.37	27.9	Round with rough edges	Dry branches of thorny trees with leaves inside
	Mean ± SE		11.64 ± 1.35	10.14 ± 0.90	27.4 ± 0.28		

Table VI- Vegetation preference of red turtle dove (*Streptopelia tranquebarica*), Indian robin (*Saxicoloides fulicatus*) and weaver bird (*Ploceus philippinus*) for nesting at Pabbi Range Kharian

Bird species	Sampling site	Vegetation species used for nesting	Height of tree (m)	Height of nest on tree (m) from ground level	Nest diameter (cm)	Nest shape	Nest composition
Red turtle dove	IV	*Acacia nilotica*	4.04	3.09	21.4	Round	Grass stem, roots and small shrub branches
		Acacia nilotica	5.9	5.00	22.1	Round	Grass stem, roots and small shrub branches
		Acacia nilotica	8.83	8.01	22.4	Round	Grass stem, roots and small shrub branches
	Mean ± SE		6.25 ± 1.39	5.36 ± 1.43	21.96± 0.29		
Indian robin	I	*Eucalyptus cama-ldulensis*	7.92	6.05	22.4	Deep cup shaped	Tree leaves with grass leaves and roots
	Mean ± SE		7.92± 0.00	6.05± 0.00	22.4 ± 0.00		
Weaver bird (N=30)	IV	*Acacia nilotica*	8.66	8.13	17.6	Pendulum shaped	Grass leaves and branches
	Mean ± SE		8.66 ± 0.00	8.13 ± 0.00	17.6 ± 0.00		

and used for nesting by different bird species except for at sampling site-V where *Poplus deltoides* which overall stood second in specific tree species, was used for nesting (Supplementary Table I).

In case of trees and birds, highest mean value was recorded for House Crow in relation to *Populus deltoides* at sampling site-V (Supplementary Table I). The possible combinations including trees with nesting site, trees with birds and birds with nesting sites showed no significant relationship among these parameters tested while there was a small element of specific preference as seen for Black Kite which used only *Bombax ceiba* for its nesting regardless of its presence at all five sampling sites. House Crows showed a change in preference in their nesting at site-V by choosing *Poplus deltoides* over *Acacia nilotica,* hence showing flexibility in its nesting tree selection. Overall the analyzed data showed that all mean values of all the parameters tested for nesting were non-significant (Supplementary Table I).

Breeding performance of Avifauna

Nests of seven different bird species were recorded at different sampling sites at the Pabbi Range forest Kharian; six of these species showed successful breeding performance while the weaver bird did not show any evidence of its breeding in spite of having maximum numbers of nests (30).

Clutch size

Among six different avifauna species, maximum mean clutch size was recorded for common myna, black drongo and Indian robin (three in each case), followed by common crow (2.92 ± 0.38), black kite (2.33 ± 0.33), and least by red turtle dove (1.5 ± 1.00) (Table VII).

Hatching success

Maximum mean hatching success was shown by black drongo (88.86 ± 11.13) at four different sites, followed by common myna (77.75 ± 11.12), common crow (62.80 ± 11.65), black kite (38.86 ± 20.01) and least by red turtle dove (16.65 ± 9.22). Indian robin also showed 66.6 ± 0.0 % hatching success but it had only one nest (Table VII).

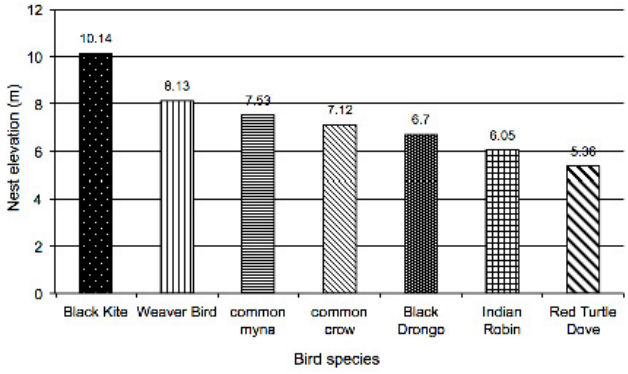

Fig. 3. Average nest height (m) of different bird species at Pabbi Range forest Kharian, Pakistan during the current study period.

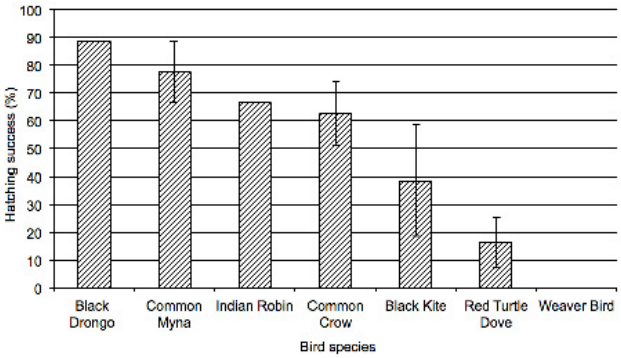

Fig. 4. Hatching success (%) of different bird species as an evidence of breeding performance at Pabbi Range Forest Kharian, Pakistan.

Table VII.- Breeding performance of avifauna at Pabbi Range Kharian during study period.

Bird species	No. of nests studied	Mean clutch size	Mean hatching success (%)
Common myna	6	3.00 ± 0.00	77.75 ± 11.12
Common crow	13	2.92 ± 0.38	62.80 ± 11.65
Black drongo	4	3.00 ± 0.00	88.86 ± 11.13
Black kite	3	2.33 ± 0.33	38.86 ± 20.01
Red turtle dove	3	1.50 ± 1.00	16.65 ± 9.22
Indian robin	1	3.00 ± 0.00	66.6 ± 0.0
Weaver bird	30	-	-

DISCUSSION

When a bird constructs a nest, several factors are brought into consideration; the most important being minimizing the risk of predation. In order to avoid predation, the nest should possess all the primary as well as secondary qualities necessary for bird's survival yet it has to be almost inaccessible to the potential predators; in doing so the nest may be hidden or camouflaged and during the process of nesting they are likely to use fresh leaves and grass stems for temperature regulation (Hartman and Oring, 2003). Birds are very particular about the materials selected for constructing the nest and the care and attention is given to their nest construction (Pettingill, 1985).

The bird species are very particular about the material selected for constructing the nest and the care and attention given to their nest construction. At first glance, the dirtiest looking nest of cape sparrow *Passer melanurus* was surprising, since it seemed to have been built with little discrimination; but on closer inspection it showed that each part of the structure was selected for properties such as flexibility, projections, smoothness, color and even the smell locking (Pettingill, 1985). A very similar situation was found in the current study at site-III, regarding nests of the black kite and common crow. Not only did they use flexible branches of trees but also, they removed spikes from the inner portion of the nest; external portion containing spiky material of the branches acted as anchor which supported and gripped the branches of the tree where the nest was placed. Black kite used the central position of the main stem of tree *Bombax ceiba* to build their nest as the branches of the tree served as passive support and hence anchored the nest. The common myna used leaves and stems of khabbal grass *Cynodon dactylon* as well as stems and branches of Sanatha *Dodonaea viscosa* for nest construction. Black drongo used roots of some grass species and branches of mulberry *Morus alba* and dharek *Melia azedarach*, eucalyptus branches were also present but in small quantity/number.

Looking into the reasons why black kites always preferred semal tree in the study area for nesting? it seems that branches of this tree species act as support material, thorny surface of the tree makes it difficult for the parasitic insets to invade the nest, height of the tree provides good vantage point to guard against the predators and to look for the prey, surface of branches, being rigid, provide friction force that keeps nest in place and prevents it from falling or sliding on the branches of the tree.

Selection of dry portion of plants as nesting material may be to provide support, flexibility and shape maintenance. Jaenson (1990) reported that plant species are mainly used as nesting material by birds because of their aromatic properties and it plays important role during the hatching process. The nesting material also has some toxic effect for the parasites and invading insects including many species of termites and beetles (Jaenson, 1990). Some earlier studies such as by Cowie and Hinsley (1988). Banbura *et al*. (1995) and Lambrechts and Santos (2000) reported a variety of birds that used fresh leaves in their nests because of the fragrance of plant leaves which drove away the small predators from the nests. In the current study, it was also observed in the nests of common myna and Indian robin which also used leaves of *Eucalyptus camaldulensis* to place in the nest, on which they built the nest. It is already established that leaves of this plant species possess some aromatic as well as medicinal fragrance, which in this case, helped avoid nest predation.

Nests having the most complicated structure in terms of construction and shape are reported for passerine woven nests of *orpendolas* and weaver finches. They build a complex woven nest that is chambered from inside. In the initial stage the nest has two openings with overall elliptical shape. Later on, when bird fills the chamber walls with mud, the second opening is closed that becomes a pouch where eggs are laid. The remaining opening is further constructed downwards giving a narrow tube like shape that serves as both entry and exit point for the bird (Kartesz and Meacham ,1999). A quite similar situation was evident in the current study for weaver bird at one sampling site. However, nesting did not terminate in successful breeding as no evidence was found of egg laying of this bird species in the study area.

As discussed above, some birds use different kinds of aromatic plants as nesting material just because of unique properties of that plant. Doves use eucalyptus leaves in their nests that act as natural repellent to parasites and even to some predators. It is evident that these leaves also provide reliable ground inside the nest for egg laying and hatching. Some species have been observed to cover their eggs with these leaves for protection purposes. Some species particularly doves in the central Punjab use cotton plant as primary nesting material due to its temperature bearing properties and efficient cover qualities inside the nest (Pullis La Rouche, 2006). But in the current study, red turtle dove used *Acacia nilotica* for nesting, may be being thorny in nature, to avoid nest predation. However, Indian robin did use *Eucalyptus camaldulensis* for nesting and subsequent successful breeding.

As regards breeding activity, six out of seven bird species were found successfully breeding in the study area, which is indicative of successful nesting by different bird species. Nest composition and location are important factors in studying the utility of plant material used by avifauna and microclimatic conditions inside the nest are

also very important for birds, either in the embryonic stage, or nestling stage. However, nest constructed comparatively higher makes it difficult to sustain energy because of high metabolism and low temperature, particularly at night (Calder, 1973).

CONCLUSION

The study highlights the major avifauna species inhabiting Pabbi Range forest Kharian, Pakistan, their comparative plant/tree preference for nesting, nest height above ground level, their clutch size, incubation period and hatching success.

Statement of conflict of interest

We declare no conflict of interest.

Supplementary material

There is supplementary material associated with this article. Access the material online at: http://dx.doi.org/10.17582/journal.pjz/2018.50.1.329.338

REFERENCES

Banbura, J., Blondel, J., De Wilde-Lambrechts, H. and Perret, P., 1995. Why do female blue tits (*Parus caeruleus*) bring fresh plants to their nests? *J. Ornithol.*, **136:** 217–221. https://doi.org/10.1007/BF01651244

Calder, W.A., 1973. Microhabitat selection during nesting of hummingbirds in the rocky mountains. *Ecology,* **54:** 127-134. https://doi.org/10.2307/1934381

Clayton, D.H. and Moore, J., 1997. *Host parasite evolution: General principles and avian models*,Oxford University Press, Oxford.

Cowie, R.J. and Hinsley, S.A., 1998. Timing of return with green vegetation by nesting blue tits *Parus caeruleus*. *Ibis,* **130**: 53–559.

Dial, K.P., 2003. Evolution of avian locomotion: correlates of flight style, locomotors modules, nesting biology, body size, development, and the origin of flapping flight. *Auk*, **120**: 941-952. https://doi.org/10.2307/4090265 https://doi.org/10.1642/0004-8038(2003)120[0941:EOALCO]2.0.CO;2

Grimmett, R., Roberts, T. and Inskipp, T., 2007. *Birds of Pakistan*. Christopher Helm London.

Hartman, C.A. and Oring, L.W., 2003. Orientation and microclimate of horned lark nests: The importance of shade. *Condor*, **105**: 158-163. https://doi.org/10.1650/0010-5422(2003)105[158:OAMOHL]2.0.CO;2

Hussain, T., Ashraf, I., Ahmed, I., Ruby, T., Rafay, M., Abdullah, M., Siddiaq, N., Nawaz, S. and Akhtar, S., 2016. Comparison of diet analysis of Eurasian Sparrowhawk *Accipiter nisus* and nlack kite *Milvus migrans* (accipitridae; Accipitriformes) from Southern Punjab, Pakistan. *Pakistan J. Zool.,* **48**: 789-794.

Jaenson, T.G.T., 1990. Vector roles of *Fennoscandian mosquitoes* attracted to mammals, birds and frogs. *Med. Vet. Ent.*, **4**: 221–226. https://doi.org/10.1111/j.1365-2915.1990.tb00280.x

Kartesz, J.T. and Meacham, C.A., 1999. *Synthesis of the North American flora. Version 1.0.* North Carolina Botanical Garden, Chapel Hill, North Carolina, USA.

Lambrechts, M.M. and Santos, D.A., 2000. Aromatic herbs in Corsican blue tit nests: The Potpourri hypothesis. *Acta Oecol*., **21**: 175–178. https://doi.org/10.1016/S1146-609X(00)00122-3

Mahmood, T., Hussain, R., Rais, M., Hussain, I. and Nadeem, M. S. 2012 . Habitat analysis and population estimates of three falcon species, red-headed merlin (*Falco chicquera*), common kestrel (*Falco tinnunculus*) and saker falcon (*Falco cherrug*) inhabiting District Chakwal, Pakistan. *Pakistan J. Zool.,* **43**: 787-798.

Pettingill, O.S., 1985. *Ornithology in laboratory and field*, Fifth ed. Academic Press, New York, NY. 1985.

Pullis La Rouche, G., 2006. Birding in the United States: A demographic and economic analysis. In: *Waterbirds around the world* (eds. G.C. Boere, C.A. Galbraith, and D.A. Stroud). Stationery Office, Edinburgh, UK, pp. 841-846.

Strayer, D.L., Eviner, V.T., Jeschke, J.M. and Pace, M.L., 2006. Understanding the long-term effects of species invasions. *Trends Ecol. Evol.,* **21**: 645–651 https://doi.org/10.1016/j.tree.2006.07.007