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The role of plant species diversity on nesting birds in Mudumalai Wildlife Sanctuary, India.

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Abstract

Plants species selected for nest building of birds have largely been related to the supportive nature of plants to protect eggs and chicks from predators and other environmental factors. Here, it is suggested that architectural suitability of a plant species to hold / support a nest a could also be an important component in the nest-site selection. In total 302 nests of 31 bird species were found in a 20 ha study area in Mudumalai Wildlife Sanctuary, India. Nests were not found on all the 28 species of trees and 17 species of shrubs recorded in the study area. Among the plants *Anogeissus latifolia* supported largely hole and cup shaped nests while *Acacia* spp. and *Gymnosporia montana* supported predominantly dome shaped nests built by munias. Similarly, larger and broader trees such as *Terminalia bellerica* and *Bombax ceiba* supported nests of big sized raptors while *Tectona grandis* supported largely hole-nests. Hence, there may be an architectural compatibility existing between nests and nest-plants and it largely determine the kind of nests it can support.

Key words : architectural compatibility, hole-nest, nest-plant, nest, plant architecture.

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INTRODUCTION

Delineating habitat requirements and preferences of species is essential for conservation planning of birds. Hence, nest-site selection has been widely discussed for single or a group of bird species. Besides, the reason for selecting a particular plant is largely related to the supportive nature of plants to protect eggs and chicks from predators and other environmental factors (Forstmeier and Weiss, 2004; Schmidt *et al.,* 2006; Verlando and Márquez, 2002; Joyce, 1993; Eggers et al., 2006; Peluc *et al.,* 2008; Gokula, 2012; Gokula and Vijayan, 2003; Gokula, 2000 a, b, 2001

Here, it is suggested that structural suitability of a plant species (branching geometry, growth form, nature / hardness of wood) to hold a nest may also be an important component in the nest-site selection, especially through its influence on nest-plant selection. It is assumed that different type of nests require different architectural / physical characteristics of plants to hold / support it and hence this would relate to the existence of architectural compatibility between nests and nest-plant species.

Plant architecture is defined as the three-dimensional organisation of the plant body. For the parts of the plant that are above ground, this includes the branching pattern, as well as the size, shape and position of leaves and floral parts. As plant architecture is species specific, indicating that it is under strict genetic control (Didier Reinhardt and Cris Kuhlemeier, 2002), it is also likely to be one of the major factors that determine the type of nests (hole, cup, platform, etc.) it can support. Hence, it is likely that few plant species would be more suitable to support certain type of nests of bird species in an area because of its morphological advantage over other plant species. The present article deals with the role plant species diversity on nesting birds with particular reference to the Mudumalai Wildlife Sanctuary, Tamil Nadu, India.

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Study Area

The Mudumalai Wildlife Sanctuary is located between 11^{0}30' to 11^{0}39' N and 76^{0}27' and 76^{0}43' E and situated at an average elevation of 1000 m in the Nilgiris district, Tamil Nadu. The climate is moderate, and temperatures vary from 14^0-17^{0}C during December-January to 29^0-33^{0}C during March-May. The annual rainfall varies from 600 mm to 2000 mm, which is received in two periods. The first is of high rainfall (June-August) from the Southwest Monsoon and the second period brings low rainfall (September-November) from the Northeast Monsoon. The sanctuary is drained mainly by a perennial river Moyar and by various streams. Corresponding to the rainfall, the vegetation varies from thorn forest in the east to semi-evergreen forest in the west. The present study was carried out in a 20 ha plot consisted of a combination of tree species such as *Tectona grandis,* *Anogeissus latifolia Acacia spp*. (including *A. chundra, A. leucopholea,* and *A. ferruginea), Anogeissus latifolia, Ziziphus* spp., *Sapindus emarginatus, Phyllanthus emblica, Erythroxylum monogynum, Cassia fistula,* and *Capparis* spp.

MATERIALS AND METHODS

Searches were made on foot to assess the nest structures by examining all the trees and shrubs present in a 20 ha plot. An active nest was corroborated if adults were seen performing breeding activities (nest-building or renovation, incubation, feeding the young) in or adjacent to the nest. Nests were classified based on their shape as cup (e.g. nests of bulbuls, babblers), cone (e.g. nests of paradise flycatcher, oriole), dome (e.g. nests of munia) and platform (e.g. nests of raptors). The plant species on which the nest was constructed was identified upto species level. Vegetation was sampled to estimate the density and diversity of plant species in 50X20 m plots established at every 100 m interval. In total, 70 plots were laid and all the trees and shrubs present within the plots were identified at species level. Number of individuals of each tree and shrub species was counted. A snag is a standing dead or partially dead tree (Evans and Conner, 1979). But, only trees completely dead and >20 cm Diameter at Breast Height were considered as snags in the present study. Diversity was calculated using Shannon-Weaner index (1949) $H' = -d\ p_i \log p_i$ (Where H'= diversity and pi= the proportion of observation in subset i). The guidelines proposed by Praveen et al. (2016) were followed for the avian classification.

RESULTS

In total, 302 nests of 31 bird species were found on 17 species of trees and nine shrub species were recorded in the study area (Table 1 and 2). Although 304 individuals of 28 tree species were recorded, only a few tree species viz., *Acacia chundra, Erythroxylum monogynum, Eucalyptus globulus, Tectona grandis* and *Anogeissus latifolia* were abundant. Of the 28 tree species, only 17 were used for nesting by birds. Similarly birds used nine out of 17 shrub species for nesting. As identification was not possible for snags, it was considered as a plant substrate regardless of species. Of the 26 plants, the diversity of nests was greater on *Anogeissus latifolia* (2.0) followed by Snags (1.6). Species such as *Lantana camara, Erythroxylum monogynum, Ziziphus mauritiana, Randia dumetorum* and *Acacia chundra* were the next group that supported more or less the same diversity of nests (Table 2).

Nests were found even on succulent species such as *Euphorbia antiquorum* and *Opuntia dillenii*. Although the maximum number of nests was on *Toddalia asiatica*, only seven species nested on this species. Moreover, no nest was found on this species when it was not associated with other plant species such as *Gymnosporia sp, Erythroxylum sp* or *Strychnos potatorum*. Mostly dome-shaped nests built by various munia species were found on this species.

DISCUSSION

On the whole, 26 plant species were recorded as substrate or platform for 302 nests of 31 bird species. However, among the 26 plant species, only nine species of plants could support more number of nests. Titus and Mosher (1987) observed with reference to raptors and found that not all trees were suitable for nest location. It is because the size and geometry of branching of all trees did not produce an acceptable fork within the preferred vertical range of the bird species. It has been suggested that the presence of numerous lateral branches and associated crotches, certain hybrid trees might offer better nest-sites to some birds (Martinsen and Whitham, 1994). Some species might use tactile and visual stimuli from tree forks to ascertain their suitability as nest locations (Nickell, 1958; Ficken, 1964). Hubert (1993) reported that the characteristics of trees such as the angle between the nest branch and trunk, height of the tree, the crown volume, and the average trunk spacing were important in determining the choice of nest-site selection of Common Buzzrd. Thus different plant species have different branching geometry to which birds respond to build nests on. The arrangements of branches and twigs on certain plant species provide better sites for nests for some species of birds. Hence, nine species of plants, because of their likely architectural compatibility with nests, could support more number of nests than other plant species.

In the present study, it was evident that particular species or groups of plants are better suitable for particular types of nests. For example, species such as *Anogeissus latifolia* supported largely hole and cup-shaped (e.g. nests of bulbul, fantail and drongos) nests while *Acacia* spp. and *Gymnosporia montana* largely supported dome-nests (nests of munia). Similarly larger and broader trees such as *Terminalia bellerica* and *Bombax ceiba* supported larger platform nests (nests of raptors) while *Tectona grandis* supported mainly hole-nests. It shows that there seems to be an existence of architectural compatibility between plant species and nests which likely determines the nest and plant relation.

Nest-site selection has widely been discussed for single or a group of bird species. Besides, the reason for selecting a particular plant has largely been related to the biology of the bird species (Forstmeier and Weiss,

Table 1. Number of nests of various bird species found in the study area.

Sl. No.	Order	Family	English Name	*Scientific Name*	Type of nest	No. of nests
1	Columbiformes	Columbidae	Spotted Dove	*Streptopelia chinensis*	Platform	1
2	Charadriiformes	Charadriidae	Red-wattled Lapwing	*Vanellus indicus*	Ground	1
3	Accipitriformes	Accipitridae	Changeable Hawk Eagle	*Nisaetus cirrhatus*	Platform	2
4	Accipitriformes	Accipitridae	Brahminy Kite	*Haliastur indus*	Platform	10
5	Piciformes	Picidae	Lesser Golden-backed Woodpecker	*Dinopium benghalense*	Hole	5
6	Piciformes	Picidae	Lesser Yellow-naped Woodpecker	*Picus chlorolophus*	Hole	1
7	Piciformes	Picidae	Yellow-fronted Pied Woodpecker	*Dendrocopos mahrattensis*	Hole	1
8	Piciformes	Ramphastidae	Brown-headed Barbet	*Psilopogon zeylanicus*	Hole	1
9	Psittaciformes	Psittaculidae	Plum-headed Parakeet	*Psittacula cyanocephala*	Hole	16
10	Passeriformes	Campephagidae	White-bellied Minivet	*Pericrocotus erythropygius*	Cup	3
11	Passeriformes	Campephagidae	Scarlet Minivet	*Pericrocotus flammeus*	Cup	5
12	Passeriformes	Campephagidae	Black-headed Cuckooshrike	Lalage melanoptera	Cup	3
13	Passeriformes	Oriolidae	Black-hooded Oriole	*Oriolus xanthornus*	Cone	2
14	Passeriformes	Vangidae	Common Woodshrike	*Tephrodornis pondicerianus*	Cup	1
15	Passeriformes	Dicruridae	White-bellied Drongo	*Dicrurus caerulescens*	Cup	1
16	Passeriformes	Rhipiduridae	White-browed Fantail	*Rhipidura aureola*	Cup	24
17	Passeriformes	Laniidae	Bay-backed Shrike	*Lanius vittatus*	Cup	24
18	Passeriformes	Monarchidae	Indian Paradise-flycatcher	*Terpsiphone paradisi*	Cone	11
19	Passeriformes	Nectariniidae	Purple Sunbird	*Cinnyris asiaticus*	Cup	10
20	Passeriformes	Estrildidae	Indian Silverbill	*Euodice malabarica*	Dome	5
21	Passeriformes	Estrildidae	Scaly-breasted Munia	*Lonchura punctulata*	Dome	63
22	Passeriformes	Paridae	Cinereous Tit	*Parus cinereus*	Hole	1
23	Passeriformes	Cisticolidae	Common Tailorbird	*Orthotomus sutorius*	-	1
24	Passeriformes	Pycnonotidae	Red-whiskered Bulbul	*Pycnonotus jocosus*	Cup	2
25	Passeriformes	Pycnonotidae	Red-vented Bulbul	*Pycnonotus cafer*	Cup	25
26	Passeriformes	Zosteropidae	Oriental White-eye	Zosterops palpebrosus	Cup	9
27	Passeriformes	Leiothrichidae	Yellow-billed Babbler	*Turdoides affinis*	Cup	40
28	Passeriformes	Sittidae	Chestnut-bellied Nuthatch	*Sitta castanea*	Hole	3
29	Passeriformes	Sturnidae	Common Myna	*Acridotheres tristis*	Hole	2
30	Passeriformes	Muscicapidae	Indian Robin	*Saxicoloides fulicatus*	Hole	28
31	Passeriformes	Muscicapidae	Oriental Magpie Robin	*Copsychus saularis*	Hole	1
				Total number of nests found		**302**

2004; Schmidt *et al.*, 2006; Verlando and Márquez, 2002; Joyce, 1993; Eggers *et al.*, 2006; Peluc *et al.*, 2008; Gokula,2000,2001, 2012; Gokula and Lalitha Vijayan, 2003). Very few studies have been made to relate the geometrical configuration of the plant and nesting success. Peterson (1979) and Bednarz and Dinsmore (1982) could not detect any significant influence of the geometry of the plant on the nest success while, Dijak *et al*. (1990) stated that some characteristics of the nest tree (i.e. tree size, understorey) could influence the nesting success. Although, in the present study, no nest success was calculated and related with the plant-geometry, it could possibly be speculated that the architecture could play a major role in deciding the

Table 2. Number of bird species and nests on various plants.

Plant species	Density/ha	No. of bird species nesting	No. of nests	Nest Diversity (H')
Acacia chundra	10	5	25	1.3
Acacia catechu	0.7	1	4	0
Anogeissus latifolia	63.4	13	45	2
Bombax ceiba	0.5	1	2	0
Cordia sp	0.1	1	1	0
Dalbergia latifolia	2.3	1	3	0
Elaeodendron glaucum	2.8	3	6	0.8
Erythroxylum monogynum	17	5	17	1.3
Eucalyptus sp	18.5	1	3	0
Euphorbia antiquorum	0.4	1	1	0
Ficus bengalensis	0.4	1	1	0
Gymnosporia montana	0.4	3	22	0.7
Lagerstroemia lanceolata	0.01	1	2	0
Lantana camara	*	4	30	1.2
Mangifera indica	0.01	1	1	0
Opuntia dillenii	4	1	2	0
Phyllanthus emblica	32.1	3	4	1
Pterocarpus marsupium	1.9	1	1	0
Randia dumetorum	2.2	5	13	1.4
Snag	1.5	8	23	1.6
Strychnos potatorum	0.2	1	2	0
Tectona grandis	33.5	2	7	0.5
Terminalia bellirica	0.1	1	4	0
Toddalia asiatica	10	7	50	1.2
Unidentified bush	1	2	2	0.6
Ziziphus mauritiana	0.5	4	12	1.3
Ground	-	2	19	0.2

* Density was not calculated

type of nest it could support. For example, the architecture of *Tectona grandis* may not be suitable for munia species to construct their nest because, munia needs densely interwoven and thorny lateral branches / to provide sufficient structural support so as to construct their dome shaped nest and this kind of architecture is not be found in *Tectona grandis.* In contrast, *Anogeissus latifolia* may not be suitable for nests of Eagles as they are architecturally not tall and broad to hold a raptor nest.

To avoid predation, birds build their nests more on common plant species than rare ones as finding rare species in an area would be time consuming for a predator (Martin and Roper, 1988). Although majority of the nests were on the common and abundant species present in the study area not all the common plant species were used for nesting. For example, *Tectona grandis* and *Opuntia dillenii* are although common, they could support only a few nests. Similarly plant species such as *Randia dumetorum, Acacia cateachu* were in low density, but could support more number of nests. Kozma and Mathews (1997) studied 24 plant species used as nest-plants by various bird species in Chihuahuan desert and inferred that characteristics such as dense foliage, stiff branches, spinescent stems, and greater height of these plants might be the reason for the selection even when they were in low density. Hence, the selection of plant species for nest construction could be attributed to the geometry and physical complexity of the plants rather than to their availability.

The snag or live tree of *Anogeissus latifolia* and *Tectona grandis* supported large number of hole-nests. Woodpeckers and other cavity-nesting birds are largely dependent on dead or dying trees for nest-sites (Conner *et al*., 1976; Evans and Conner, 1979; Scott, 1979; Raphael and White, 1984). Snags are highly preferred by cavity nest builders as excavation would be easy on the softer portions of dead trees. The ground moisture, flooding at the base of snags, and rain soaking at the tops may increase microclimate humidity and facilitate softening of the wood by fungal decay. Thus, the availability of holes on these two plant species might be because of the nature of the wood which is suitable for the excavators to make holes in large numbers. In the present study, both the plant species supported excavators as well as non-excavators.

CONCLUSION

The architecture of the plant (branch geometry), nature of wood (soft or hard) and the form of plant (Shrub or tree) largely determine the kind of nests it can support. The size and geometry of branching must produce an acceptable platform or base for birds to construct their typical nest within their preferred vertical limit. Hence, there may be an architectural compatibility existing between nests and nest-plants as the arrangements of branches and twigs on certain plant species provide better structural support and sites for certain nest architecture than other, and it largely determines the kind of nests it can support. Hence, structural suitability of the plant species to hold a nest would play a major role in nest-site selection of birds. The diverse vegetation, besides food, offers wider opportunity to various species of birds to construct their nests than homogeneous vegetation.

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