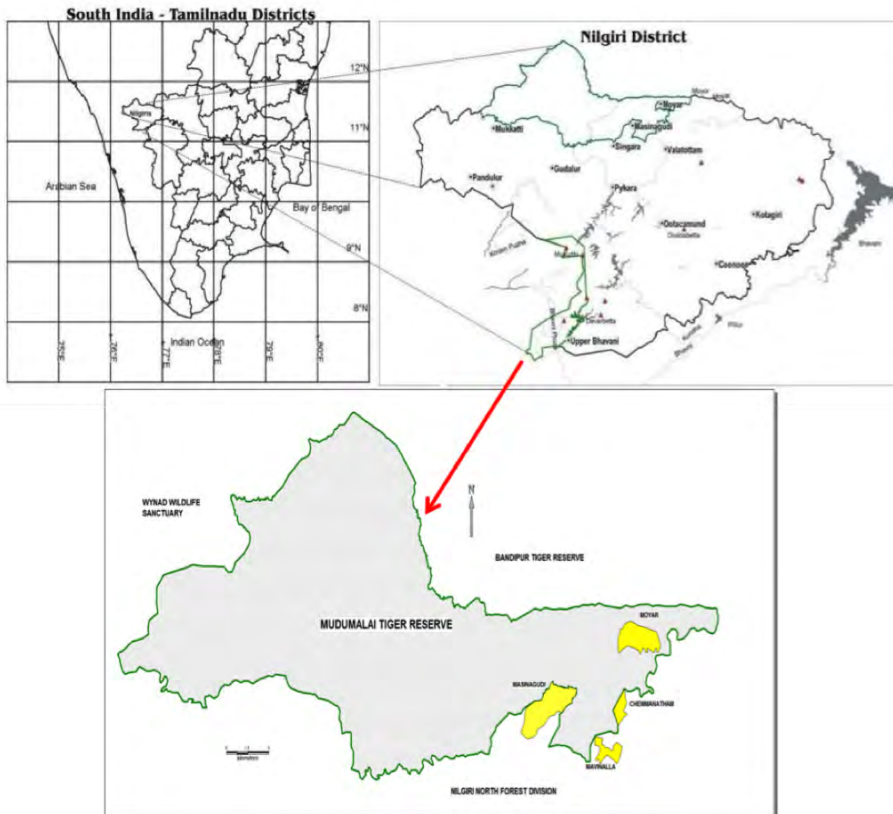


Nest-site selection of breeding birds in fragmented landscapes at Mudumalai Tiger Reserve, Tamil Nadu, India



Map of the study area (Eastern part of the Mudumalai Tiger Reserve)

The Indian subcontinent has around 1200 species of birds (Ali & Ripley 1987). The rich avifauna is partly because of its wide altitudinal range and highly varied climate and associated diversity of vegetation (Grimmett et al. 1999). The Western Ghats, identified as one of the biodiversity hotspots in the world (Myers et al. 2000) is a 1600-km long chain of mountain ranges running parallel to the western coast of the Indian peninsula (Pascal 1988). Among the three distinct sections of the Western Ghats, the south-eastern region has one of the richest tropical forests in the country (Daniel et al.

1992). Among the 1200 species of birds, the Western Ghats has nearly 508 bird species (Daniels 2003), of which 3.5% are endemic (Rajmohana & Radhakrishnan 2008) and 226 bird species recorded from Mudumalai Tiger Reserve (Gokula & Vijayan 1996). We report different nesting pattern selected by different birds in the study area.

Methodology

The study was carried out during the breeding season from December 2012 to March 2013 at Mudumalai Tiger Reserve is located in the Nilgiri District of Tamil Nadu,

11°32′–11°42′N & 76°20′–76°45′E. It extends over an area of 321km² (Ashokkumar et al. 2010) and forms a part of the Nilgiri Biosphere Reserve. Mudumalai Tiger Reserve (MTR) is located in the hyper diverse Western Ghats of central part of the Nilgiri Biosphere Reserve (NBR), which is one of the 34 Biodiversity hotspots of the world (Myers et al. 2000; Mittermeier et al. 2008). In April 2007, the Tamil Nadu state government declared Mudumalai as a Tiger Reserve. The present study was carried out in fragmented landscapes of eastern part of the Mudumalai Tiger Reserve (Masinagudi range). It extends over an area of 48km² and consists of four villages: Moyar, Masinagudi, Mavanalla and Chemmanattam.

Nest site selection of birds:

Wherever the nest was sighted, the name of the species, shape of the nest, location of the nest by using (GPS) was recorded. The nesting materials used for the construction of nests were recorded with standard methodologies as described by Pettingill (1985) and Soni et al. (2004). The photographs were taken with a SONY 30X Digital Camera. For hole nesting birds, orientation was recorded by using a compass based on the direction of the nest. If it was hanging, dome or platform nests, the orientation were recorded based on the position of the nest. Some birds used to construct nest on the central part of the stump. For such nests, orientation was recorded based on the open place for entering air, sunlight and bird to nest. Other parameters like tree name, tree height (Visually estimated), Girth at Breast Height

(GBH) by using measuring tape, crown diameter, distance from water bodies, roads and human settlements were also recorded.

Results & Discussion

A total of 26 species of nesting bird species belonging to 15 families were recorded and 100 nests were recorded during the study period among which White-rumped Munia (13 nests) had the highest number of nests followed by the Red-vented Bulbul (9 nests). Six different kinds of nesting patterns, viz; hole nesters (12 species), platform nesters (7 species), cup and dome (3 species), hanging nesters (2 species) were recorded. Three different kinds of nest sites like tree nesters (20 species), shrub nesters (4 species) and wall nesters (5 species) were recorded. Interestingly we found that the only two species were utilizing two different nest sites, which are Chestnut-shouldered Petronia, tree and wall and Red-vented Bulbul, tree and shrub. Detailed results are given in Tables 1, and 2. Apart from that a total of 30 bird nesting plant species noted during the study period (Table 3).

Nest construction and placement had correlates with the breeding season, suitable nest sites, nesting material availability, food availability and predator's interaction (Dial 2003). The birds use a variety of nesting material for nest construction but the soft fibers, grasses, twigs, leaves, cotton, threads, bark and spider web are mostly preferred (Ali et al. 2011). In this study, 14 species of hole nesters using a variety of locations such as trees and walls were recorded.

Table.1. List of nesting birds species, nest type, nest materials, # nests, mean tree height, mean GBH, mean crown diameter, mean nest height, mean, D.F.W=Distance from water, D.F.H.S=Distance from human settlement and D.F.R=Distance from road noted during the study period.

S. No	Species name	Scientific name	Family	Nest-Site	Nest type	Nest Materials	# Nests	Mean Tree height (m)	Mean GBH (m)	Mean Crown diameter (m)	Mean Nest height (m)	Mean D.F.W (m)	Mean D.F.H.S (m)	Mean D.F.R (m)
1	Black Kite	<i>Milvus migrans</i>	Accipitridae	Tree	Platform	Twigs, cloths	6	15.8	4.5	88.3	14.8	175	131.7	116.7
2	Brahminy Kite	<i>Haliastur indus</i>	Accipitridae	Tree	Platform	Twigs	5	16	1.8	33.2	15.2	780	107.6	119
3	Changeable Hawk Eagle	<i>Nisaetus cirrhatus</i>	Accipitridae	Tree	Platform	Twigs	2	24	3.8	64	23.3	51	800	405
4	Oriental Honey-buzzard	<i>Pernis ptilorhynchus</i>	Accipitridae	Tree	Platform	Twigs, leaves	1	32	6.2	95	30	1000	1000	500
5	House Crow	<i>Corvus splendens</i>	Corvidae	Tree	Platform	Twigs, fiber, cloths	1	14	1.7	30	13	50	50	10
6	Large-billed Crow	<i>Corvus macrorhynchos</i>	Corvidae	Tree	Platform	Twigs, fiber, cloths	5	13.8	1.4	28.4	12.9	563	244.4	246
7	Spotted Dove	<i>Spilopelia chinensis</i>	Columbidae	Tree	Platform	Twigs, Grasses	2	5	0.8 (cm)	15	2.5	225	4.5	13.5
8	Coppersmith Barbet	<i>Psilopogon haemacephalus</i>	Megalaimidae	Tree	Hole	None	8	7.7	1.2	24.6	5	526.3	130.1	15.4
9	White-cheeked Barbet	<i>Psilopogon viridis</i>	Megalaimidae	Tree	Hole	None	6	16.7	3.8	28.3	11.7	373.3	272.5	136.7
10	Oriental Magpie Robin	<i>Copsychus saularis</i>	Muscicapidae	Tree	Hole	Fibres , grasses	2	12	1.8	37	7	455	255	27.5
11	Indian Roller	<i>Coracias benghalensis</i>	Coraciidae	Tree	Hole	None	1	7	0.9 (cm)	0	6	800	500	100
12	Rose-ringed Parakeet	<i>Psittacula krameri</i>	Psittaculidae	Tree	Hole	None	1	10	0.8 (cm)	0	9	200	20	10
13	Chestnut-shouldered Petronia	<i>Gymnoris xanthocollis</i>	Passeridae	Tree	Hole	Grasses, feathers	1	22	6.7	0	16	20	500	50
				Wall		Grasses, feathers	1	3	0	2.9	50	5	25	
14	Brown-capped Pygmy Woodpecker	<i>Picoides nanus</i>	Picidae	Tree	Hole	None	2	22	6.7	0	15	20	500	50

S. No	Species name	Scientific name	Family	Nest-Site	Nest type	Nest Materials	# Nests	Mean Tree height (m)	Mean GBH (m)	Mean Crown diameter (m)	Mean Nest height (m)	Mean D.F.W (m)	Mean D.F.H.S (m)	Mean D.F.R (m)
15	Streak throated Woodpecker	<i>Picus xanthopygaeus</i>	Picidae	Tree	Hole	None	1	11	0.8 (cm)	0	3	500	600	850
16	Yellow-crowned Woodpecker	<i>Leopicus mahratensis</i>	Picidae	Tree	Hole	None	1	14	1	0	1.1	20	200	50
17	White-rumped Munia	<i>Lonchura striata</i>	Estrildidae	Tree	Dome	Grasses, feathers	13	7.3	6.2	20	4.5	400	285.7	170
				Shrub			7	2.7	0	2	392.9	315.1	127.1	
18	Scaly-breasted Munia	<i>Lonchura punctulata</i>	Estrildidae	Tree	Dome	Grasses	3	5.7	0.7 (cm)	15	4.7	700	333.3	223.3
19	Purple Sunbird	<i>Cinnyris asiaticus</i>	Nectariniidae	Tree	Hanging	Threads, cotton, fibres, bark	1	7	0.6 (cm)	18	5	1000	100	100
20	Red-vented Bulbul	<i>Pycnonotus cafer</i>	Pycnonotidae	Tree	Cup	Twigs, Leaves, Grasses	2	5.7	1.1	11.5	4.9	225	8.5	55
				Shrub			7	3	0	1.3	462.1	377.1	14.1	
21	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	Pycnonotidae	Shrub	Cup	Twigs, Grasses	1	1.8	3	0	1.9	5	200	4
22	Purple-rumped Sunbird	<i>Leptocoma zeylonica</i>	Nectariniidae	Shrub	Hanging	Leaves, grasses, spider web, bark	7	2	4.1	0	2.3	220.4	394.7	185.1
23	Blue beared Bee-eater	<i>Nyctornis athertoni</i>	Meropidae	Wall	Hole	None	1	3	0	0	2	4	300.0	30
24	White-breasted kingfisher	<i>Halcyon smyrnensis</i>	Halcyonidae	Wall	Hole	None	1	2	0	0	1.5	200	1000	40
25	Indian Robin	<i>Saxicoloides fulicatus</i>	Muscicapidae	Wall	Hole	Cotton, fibers, grasses	7	4	0	0	3	377.8	16.4	29
26	Red-rumped Swallow	<i>Cecropis daurica</i>	Hirundinidae	Wall	Hole	Mud, feathers	4	2.7	0	0	2.7	287.5	43.7	23.7

Photographic evidence of nests and nest sites of different bird species in the study area



Black Kite
Milvus migrans
GPS Location: 11°33.960'N & 076°38.214'E, 11°34.333'N & 076°38.682'E and 11°33.977'N & 076°38.035'E



House Crow
Corvus splendens
GPS Location: 11°36.048'N & 076°41.324'E



White-cheeked Barbet
Psilopogon viridis
GPS Location: 11°34.340'N & 076°38.848'E, 11°36.339'N & 076°41.555'E and 11°36.339'N & 076°41.555'E



Chestnut-shouldered Petronia
Gymnoris xanthocollis
GPS Location: 11°36.339'N & 076°41.555'E and 11°36.030'N & 076°41.317'E



Brahminy Kite
Haliastur indus
GPS Location: 11°34.437'N & 076°38.708'E, 11°34.075'N & 076°38.569'E, 11°36.339'N & 076°41.555'E and 11°36.339'N & 076°41.555'E



Large-billed Crow
Corvus macrorhynchos
GPS Location: 11°34.074'N & 076°38.576'E and 11°34.074'N & 076°38.573'E



Oriental Magpie Robin
Copsychus saularis



Brown-capped Pygmy Woodpecker
Picoides nanus



Changeable Hawk Eagle
Nisaetus cirrhatus
GPS Location: 11°35.683'N & 076°41.238'E and 11°33.629'N & 076°38.121'E



Spotted Dove
Spilopelia chinensis
GPS Location: 11°36.282'N & 076°41.555'E and 11°36.220'N & 076°41.707'E



Indian Roller
Coracias benghalensis
GPS Location: 11°35.729'N & 076°41.699'E



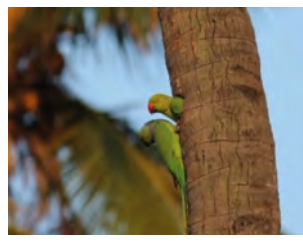
Streak-throated Woodpecker
Picus xanthopygaeus



Oriental Honey-buzzard
Pernis ptilorhynchus
GPS Location: 11°35.586'N & 076°41.846'E



Coppersmith Barbet
Psilopogon haemacephalus
GPS Location: 11°36.109'N & 076°41.463'E, 11°36.300'N & 076°41.564'E, 11°36.295'N & 076°41.613'E, 11°32.825'N & 076°40.592'E and 11°36.172'N & 076°41.798'E



Rose-ringed Parakeet
Psittacula krameri
GPS Location: 11°34.165'N & 076°38.866'E



Yellow-crowned Woodpecker
Leiopicus mahrattensis
GPS Location: 11°34.204'N & 076°38.952'E



White-rumped Munia
Lonchura striata
GPS Location: 11°35.930'N & 076°41.250'E, 11°36.240'N & 076°41.612'E, 11°32.995'N & 076°40.832'E, 11°36.031'N & 076°41.399'E, 11°36.024'N & 076°41.416'E, 11°36.220'N & 076°41.695'E, 11°36.289'N & 076°41.674'E, 11°35.733'N & 076°41.684'E and 11°35.733'N & 076°41.680'E



Red-vented Bulbul
Pycnonotus cafer
GPS Location: 11°36.157'N & 076°41.844'E, 11°34.037'N & 076°38.619'E, 11°35.948'N & 076°41.267'E, 11°35.964'N & 076°41.276'E, 11°36.016'N & 076°41.420'E and 11°33.930'N & 076°38.574'E



Blue-beared Bee-eater
Nyctornis athertoni



Indian Robin
Saxicoloides fulicatus
GPS Location: 11°35.988'N & 076°41.296'E, 11°36.264'N & 076°41.550'E, 11°36.285'N & 076°41.634'E and 11°36.001'N & 076°41.354'E



Scaly-breasted Munia
Lonchura punctulata
GPS Location: 11°33.600'N & 076°38.232'E



Red whiskered Bulbul
Pycnonotus jocosus
GPS Location: 11°34.063'N & 076°38.544'E



White-breasted Kingfisher
Halcyon smyrnensis



Red rumped Swallow
Cecropis daurica
GPS Location: 11°34.015'N & 076°38.690'E



Purple Sunbird
Cinnyris asiaticus
GPS Location: 11°34.063'N & 076°38.544'E



Purple-rumped Sunbird
Leptocoma zeylonica
GPS Location: 11°35.736'N & 076°41.721'E, 11°35.753'N & 076°41.460'E, 11°35.750'N & 076°41.341'E and 11°34.368'N & 076°39.073'E

The following species were primary hole nesters without any nesting material in our observations: White-cheeked Barbet, Coppersmith Barbet, Rose-ringed Parakeet, Yellow-crowned Woodpecker, Brown-capped Pygmy Woodpecker, Streak-

throated Woodpecker, White-breasted Kingfisher and Blue beard Bee-eater. Most of the bird species used Cavity / hole nests and most bred as well in natural tree holes / cavities and holes. Ali et al. (2011) stated that some birds, such as the Rose-ringed Parakeet construct their own nests and are referred to as primary cavity nesters. Species that use natural cavities / holes constructed by primary cavity nesters are called secondary cavity/hole nesters (Ali et al. 2011). Secondary hole nesters were, Oriental Magpie Robin, Indian Robin, Indian Roller and Chestnut-shouldered Petronia that used different nest material such as grass, fiber and cotton on a variety of

Table.2. Number of bird species and number of nests recorded in different nest type during the study period.

Nest- Site	Nest type	Number of species	Number of nests
Tree (N=20)	Platform	7	22
	Hole	9	23
	Dome	2	16
	Hanging	1	1
	Cup	1	2
Shrub (N=4)	Cup	2	8
	Hanging	1	7
	Dome	1	7
Wall (N=5)	Hole	3	14
Total		27	100

N=Number of individual species

locations such as trees and walls. In our observations mostly woodpeckers, Indian roller and Rose-ringed Parakeet were found to be using wilted trees while barbets were using wilted branches of live trees. The woodpeckers used mostly hard wood trees but the barbets, parakeet and roller used softwood trees for nest construction. The platform nesting birds such as House Crow, Large-billed Crow, Brahminy Kite, Black Kite, Changeable Hawk Eagle and Oriental Honey-buzzard constructed the nests by using twigs and mostly preferred tree canopy as they are large sized birds which helps in easy movement from nest for daily activities. Spotted Dove constructed simple platform nests with small twigs and grasses. The cup nesting species like Red-vented Bulbul and Red-whiskered Bulbul used various nesting material and a variety of locations and they mostly prefer the top canopy level of the shrub, *Lantana camara*. The dome shaped nesters like White-rumped Munia and Scaly-breasted Munia

Table.3. List of bird nesting plant species noted during the study period

Bird name	Plant name
Black Kite	<i>Ficus religiosa</i>
	<i>Tamarindus indica</i>
	<i>Syzygium cumini</i>
	<i>Albizia saman</i>
Brahminy Kite	<i>Ficus benghalensis</i>
	<i>Ficus racemosa</i>
	<i>Cocos nucifera</i>
Brown-capped Pygmy Woodpecker	<i>Cacesalpinia coriaria</i> (willd)
	<i>Albizia saman</i>
Changeable Hawk Eagle	<i>Terminalia arjuna</i>
	<i>Cacesalpinia coriaria</i> (willd)
Chestnut-shouldered Petronia	<i>Albizia saman</i>
Coppersmith Barbet	<i>Moringa oleifera</i>
	Buthala maram (Tamil local name)
	<i>Artocarpus heterophyllus</i>
	<i>Delonix regia</i>
House Crow	<i>Mangifera indica</i>
Indian Roller	<i>Cocos nucifera</i>
Large-billed Crow	<i>Mangifera indica</i>
	<i>Tectona grandis</i>
	<i>Casuarina</i> sp.
Oriental Honey-buzzard	<i>Terminalia arjuna</i>
Purple Sunbird	<i>Acacia nilotica</i>
Purple-rumped Sunbird	<i>Rosa rubiginosa</i>
	<i>Abrus precatorius</i>
	<i>Bougainvillea</i> sp.
Red-vented Bulbul	<i>Artocarpus heterophyllus</i>
	<i>Morus alba</i>
	<i>Lantana camara</i>
Red-whiskered Bulbul	<i>Lantana camara</i>
Rose-ringed Parakeet	<i>Cocos nucifera</i>
Scaly-breasted Munia	Eaga maram (Tamil local name)
	<i>Ziziphus mauritiana</i>
Spotted Dove	<i>Cacesalpinia coriaria</i> (willd)
	<i>Bombax ceiba</i>
	<i>Albizia saman</i>
White-rumped Munia	<i>Ziziphus mauritiana</i>
	<i>Mangifera india</i>
	Kara maram (Tamil local name)
	<i>Citrus limon</i>
Yellow-crowned Woodpecker	<i>Caesalpinia coriaria</i> (willd)

Table.4. Orientation pattern of tree and shrub nesting birds were noted during the study period.

Nest type	Nest direction			
	Northwards	Southwards	Eastwards	Westwards
Hole nests	14	13	5	2
Platform nests	0	0	15	7
Dome nests	2	11	3	0
Cup nests	9	9	8	2
Hanging nests	1	0	5	2

constructed the nests by using different material like grasses, fibers and feathers and various locations in the middle canopy level of shrubs as most preferable sites. The hanging type of nesters like Purple-rumped Sunbird and Purple Sunbird used various material viz; threads, cotton, paper, bark, and spider web at different locations. The mud nesters like Red-rumped Swallows were found to be using sandy mud and mostly prefer walls for nest construction.

The orientation also played key role for nest construction. The nest direction results show for the tree and shrub nesting species (Table 4). Of 32 hole nests 14 nests were with orientation northwards, 13 were oriented southwards, five eastwards and two westwards. Among the 22 platform nests, no nests were oriented towards the north and south, 15 were oriented towards the east 7 were towards the west. Similarly, among the 16 dome nests observed two were oriented towards north, 11 were towards east and three towards west but no nest showed south orientation. Among the 10 cup nests, none of them showed orientation towards north and south, 8 nests were towards east and two towards west. Out of the eight hanging nests, one showed orientation towards north, five towards east

and two towards west. Orientation of bird nests is habitually non-random with value to nest-site vegetation (Hoekman et al. 2002), variety of nests (Wiebe 2001), and topography (Van Horn & Donovan 1994).

The nest's orientation be able to occupy its revelation and thus its microclimate (Burton 2007), which in revolve may affect egg and nestling survival (Burton 2006), and discuss thermoregulatory benefits to incubating or brooding adults (With & Webb 1993). Nest orientation over the nesting season may reveal responses of nesting birds to changing microclimates (Hoekman et al. 2002). In general, variation in nest orientation is constant with the expectation of birds in search of protection from solar radiation (Burton 2007).

Conclusion

This paper gives additional information after Ali et al. (2011) observed nesting patterns of avifauna from Mayiladurai, Tamil Nadu, Indian region. They studied up to number of nests, nest-site, nest type and nest materials apart from that we noted nest characteristics like mean tree height, mean GBH, mean crown diameter, mean nest height, mean, D.F.W=Distance from water, D.F.H.S=Distance from human settlement and D.F.R=Distance from road. Distances from the nest site data will help to know availability of resources like food, water and shelter for various bird species in the study area. The information on nest site selection of birds in Mudumalai Tiger Reserve is scattered. Apart from few reports that exist (Gokula & Vijayan 1996) there are no other detailed studies of nest site

selection by birds. In order to fill up the lacunae, this study has been carried out to document the nest site selection by birds at eastern part of Mudumalai Tiger Reserve.

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