



## An avifaunal case study of a plateau from Goa, India: an eye opener for conservation of plateau ecosystems

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**Author Details:** DR. MINAL DESAI, as a CSIR senior research fellow worked on avian ecology in varied forest ecosystems in the Western Ghat locales adjoining Goa region. Her PhD thesis centered around bird diversity in selected unmanaged monoculture plantations vis-à-vis primary forest in the Western Ghat stretch in northern Goa. PROF. A.B. SHANBHAG, a professor of zoology at Goa University is involved in teaching and research over three decades. As a practicing field biologist he has been actively engaged in bird ecology and research on wetlands, forests and agroforests.

**Author Contribution:** The work embodied in the current paper was planned and designed under guidance of ABS and the actual field work and logistics were carried out by MD.

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**Abstract:** The lateritic plateaux typical of the midlands between the Western Ghats and the coastal plains of the Arabian Sea are known to be a unique ecosystem with a sizeable endemic flora. However, there is a total lack of studies on the faunal diversity of these plateaux, which are currently experiencing enormous anthropogenic pressures. We conducted a year-long study on the avifauna of the Taleigao Plateau, Goa. The Taleigao Plateau harbours 114 species of birds, accounting for 37% of the avifaunal diversity of the state. The resident bird population did not vary significantly through the seasons. Among the migrant birds, Rosy Starling *Sturnus roseus* was particularly partial to the plateau. Besides, five species of larks, grassland specialists were also recorded on the plateau. However, the absence of forest birds like the Malabar Pied Hornbill and the Indian Grey Hornbill (recorded earlier) and the predominance of habitat generalists like the House Crow and the Jungle Myna seemed to be the offshoot of heavy anthropogenic pressures on the plateau. It is recommended that at least some plateaux in the belt deserve to be protected from the impact of unsustainable developmental processes.

**Keywords:** Avifauna, feeding guilds, Goa, plateau, *Sturnus roseus*, Western Ghats.

## INTRODUCTION

Plateaux are the relatively flat open country sections of highlands. In Goa, they occupy a major portion of the land area (Joshi & Janarthanam 2004) in the form of extensions of the Western Ghats, a biodiversity hotspot, before they roll down to the coastal plains. The lateritic plateaux of the region have very shallow soil cover varying from a few mm to 30cm, hence they support limited vegetation in the form of herbs, shrubs and a few trees. Due to their dry barren appearance, more so during the drier months, they are some of the more highly neglected habitats, and are often considered as wastelands. Thus, they are the natural choice in the region for developmental projects in the form of industrial estates and conglomerates of government organizations. Taleigao Plateau, the seat of Goa University at a distance of 8km from the capital city of the state is not an exception. It comprises a series of central and state institutions, hotels, residential areas and recently a part of it was declared an information technology habitat. Time and again the university enters into afforestation drives on the plateau with the purpose of greening the campus.

Earlier floristic surveys revealed that the plateaux in Goa harbour the largest number of endemic plant species of the Western Ghats, especially herbs (Joshi & Janarthanam 2004). However, no work has been done on the fauna of this region (Watve 2003). All the same, most of the plateaux in the region are already ecologically dabbled, without any prior serious environmental impact assessment.

Birds are good biological indicators, hence holistic studies on the

ornithological potential of the varied habitats are of paramount significance in drawing guidelines in planning and management of these nature reserves and in turn their conservation (Williamson 1970). Habitat based analysis of bird life in Goa with respect to wetlands (Walia & Shanbhag 1999; Walia 2000; Shanbhag et al. 2001; Borges 2002) and monoculture forest plantations (Desai 2005) have been in progress for quite some time. An attempt was also made some time ago to analyze the birdlife on Taleigao Plateau (Shanbhag & Gramopadhye 1993). The study could not be taken to its logical conclusion though the occurrence of 64 species of birds in the area was reported. Subsequent work by Shyama and Gowthaman (1995) recorded only 43 species of birds in the same area that included 13 species not registered earlier. Both the reports were apparently based on a few opportunistic surveys, probably during different seasons of the year.

Although tropical/subtropical environments are sometimes assumed to be uniform throughout the year, seasonal changes in precipitation are common (Karr 1976) and environmental changes are of major importance in determining bird diversity and also breeding cycles (Snow & Snow 1964). Therefore, the present work was planned to assess the bird population in the central zone of the Taleigao Plateau through all the seasons of a year in the background of prevailing weather conditions and available food resources,

before it is too late. The study was also intended to generate baseline reference data to evolve a suitable management plan for the plateaux of the region in general.

**METHODS**

**Study area**

Taleigao Plateau (15°27'15"N & 17°50'00"E) is located at a distance of 8km from Panjim, the capital city of Goa (Image 1). It is an east west trending lateritic table land spread over approximately 296ha overlooking the sloping valleys and alluvial plains of the two major rivers, Mandovi and Zuari on its north and south respectively. Most of it is occupied by many semi Government / Government establishments and residential tenements. Its central zone houses the Goa University campus spanning an area of 173ha with its ever-increasing infrastructural facilities.

**Climate:** The climate is warm and humid, with atmospheric temperatures ranging from 21 to 36 °C. The humidity ranges from 71 to 94 %. The monsoon extends from June to September experiencing an average of 2600mm rainfall. During the post-monsoons (October and November) stray showers are expected. The region experiences the lowest temperatures in winter extending from December to

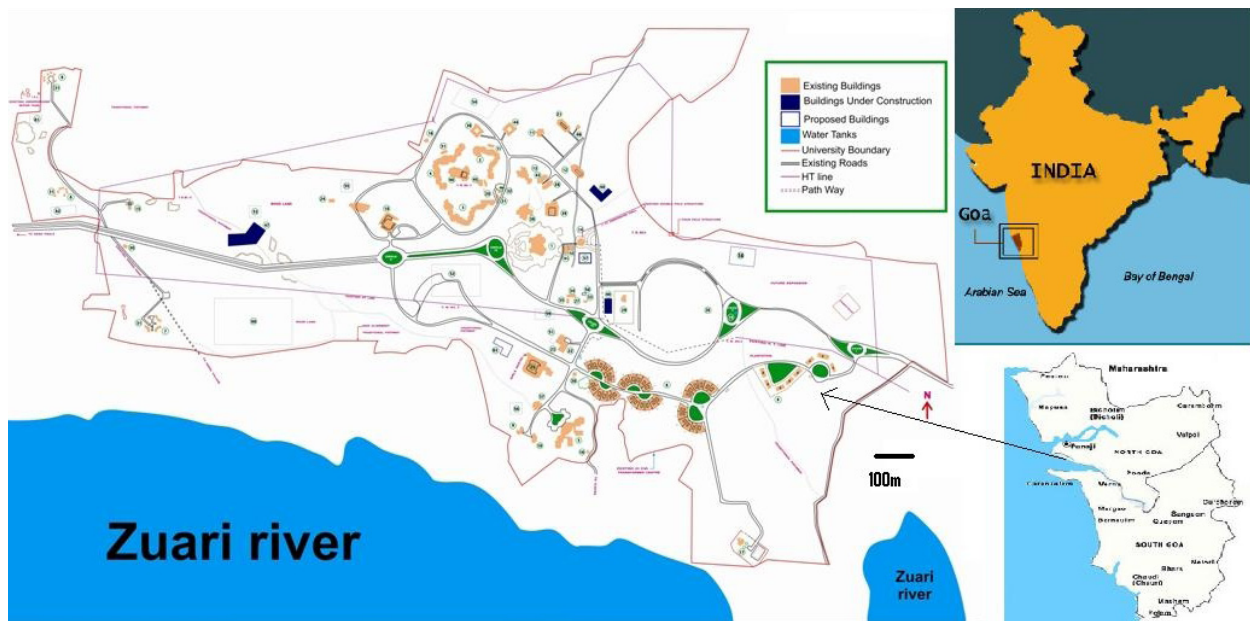


Image 1. Central zone of Taleigao Plateau, the seat of Goa University Campus

February. Summer (March–May) is the hottest season of the region.

**Vegetation:** Vegetation on the campus is moist deciduous type mixed with evergreen species. Extensive patches of grasslands on the lateritic rocky outcrops are interspersed by trees and also large thickets of shrubs. *Bombax ceiba*, *Ficus benghalensis*, *Alstonia scholaris*, *Ziziphus mauritiana*, *Peltophorum pterocarpum*, *Lannea coromandelica* are the common tree varieties while *Calycopteris floribunda*, *Holarrhena pubescens*, *Memecylon umbellatum*, *Ziziphus rugosa*, *Microcos paniculata*, *Lantana camara* dominate the scrubs. Plantations are formed of cashew, *Anacardium occidentale* and the introduced xerophyte, *Acacia auriculiformis*. The hedge plant, *Pithecellobium dulce* and shore tree, *Casuarina littorea* are recent introductions to the zone. Along with other species, *Themeda triandra* is the most common grass on the campus. The grass is often burnt during the fag end of winter or early summer. With the onset of the monsoon, rocky outcrops as well as intervening soft soil patches get transformed into lush green cover of herbaceous annuals such as *Smithia*, *Eriocaulon*, *Murdannia*, *Drosera*, and *Neanotis*.

The present study is based on intensive observations carried out over a complete year from October 2000 to September 2001. Five equidistant transects of 0.6km each, covering 3km on the whole were laid across the study area. Census was conducted on foot at monthly intervals from 0700–1000 hr using encounter rate method (Bibby et al. 2000). Common (English) names and scientific nomenclature of birds has been adopted from Manakadan & Pittie (2001).

The detailed records as to the nesting/breeding activities of birds, common associations of birds with plant species and phenology of major plant species in terms of flowering and fruiting were meticulously maintained.

The statistical significance of changes in populations of residents, migrants, passerines, non-passerines and those of various feeding guilds through the seasons were ascertained using Kruskal-Wallis and one way ANOVA tests. Statistical tests were carried out using SPSS version 6.0 for Windows. Species evenness index of Pielou (1975) and Sorensen's similarity index (Southwood 1978) were calculated.

## OBSERVATIONS AND RESULTS

Across the year, 114 species of birds belonging to 30 families and 12 orders were sighted on the campus (Table 1). Of the 19 migratory species encountered, six were distant migrants. *Clamator jacobinus* was the only monsoonal migrant on the site. All other migrants were winter visitors, some of which started arriving during the post-monsoons and stayed until summer. *Sturnus roseus* was the prominent migrant found associated with the deciduous tree *Bombax ceiba*. On the whole, *Corvus splendens*, *Acridotheres fuscus* and *Sturnus roseus* occupied the top ranks of dominance in that order. In terms of diversity, insectivores and phytophages were significantly higher than carnivores and omnivores ( $F = 33.73$ ,  $df = 3$ ,  $p \leq 0.001$ ) and on the basis of population, carnivores were significantly less in number compared to other feeding guilds ( $F = 17.84$ ,  $df = 3$ ,  $p \leq 0.001$ ).

The bird population, in terms of abundance, species composition, and the strengths of feeding guilds, prevailing weather conditions, and phenological states of the vegetation in the area, through seasons were as shown below.

**Post-monsoon (October–November):** The rainfall during the period due to the receding monsoon was 66mm. Atmospheric temperatures ranged from 22.7 to 33.2 °C. Mean wind speed was 7km/ph and average relative humidity was 85%.

The herbaceous vegetation principally consisting of grasses such as *T. triandra* and *Apluda mutica* was in fruition and had begun to dry and die. The shrubs such as *Z. rugosa* and *Z. mauritiana*, were flowering. Of the trees, *A. auriculiformis* and *A. occidentale* were in bloom and *F. benghalensis* was fruiting.

The bird population was constituted by 55 species that included six migrants. Phytophages with 39% of the population dominated the avian community. Among them only granivores such as larks, doves, and pigeons accounted for 26%. Jungle Myna, House Crow, Black Drongo, White-browed Bulbul and Common Iora were found associated with *A. auriculiformis*. Birds like orioles, White-cheeked Barbet, Plum-headed Parakeet, House Crow, Indian Treepie and Asian Koel were observed feeding on the fruits of *F. benghalensis*. White-browed Bulbul was sighted ferrying food to a thicket of vines on a *B. ceiba* tree that was followed by calls of the nestlings. Two young ones of Red-

**Table 1. Checklist of birds of Taleigao Plateau with their residential status, feeding-habits and rank of dominance.**

	Order/Family/species	Common name	Status	Feeding habit	Rank of Dominance (1-38)
	<b>Ciconiformes: Ardeidae</b>				
1	<i>Ardeola grayii</i>	Indian Pond Heron	R	C	25
2	<i>Bubulcus ibis</i>	Cattle Egret	R	I	24
	<b>Falconiformes: Accipitridae</b>				
3	<i>Elanus caeruleus*</i>	Black-shouldered Kite	R	C	37
4	<i>Milvus migrans</i>	Black Kite	R	C	25
5	<i>Haliastur indus</i>	Brahminy Kite	R	C	17
6	<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle	R	C	38
7	<i>Circus aeruginosus*</i>	Western Marsh Harrier	DM	C	30
8	<i>Accipiter badius *</i>	Shikra	R	C	35
9	<i>Accipiter nisus *</i>	Eurasian Sparrowhawk	LM	C	36
	<b>Galliformes: Megapodiidae</b>				
10	<i>Perdica asiatica</i>	Jungle Bush-Quail	R	P	30
11	<i>Galloperdix spadicea</i>	Red Spurfowl	R	O	35
12	<i>Pavo cristatus</i>	Indian Peafowl	R	O	26
	<b>Charadriiformes: Charadriidae</b>				
13	<i>Vanellus malarbaricus</i>	Yellow-wattled Lapwing	R	I	25
14	<i>Vanellus indicus</i>	Red-wattled Lapwing	R	I	10
15	<i>Xenus cinereus*</i>	Terek Sandpiper	DM	I	38
16	<i>Actitis hypoleucos*</i>	Common Sandpiper	R	I	38
	<b>Columbiformes: Columbidae</b>				
17	<i>Columba livia</i>	Blue Rock Pigeon	R	P	8
18	<i>Streptopelia orientalis*</i>	Oriental Turtle Dove	R	P	37
19	<i>Streptopelia senegalensis*</i>	Little Brown Dove	R	P	37
20	<i>Streptopelia chinensis</i>	Spotted Dove	R	P	35
21	<i>Streptopelia decaocto</i>	Eurasian Collared Dove	R	P	38
22	<i>Treron pompadora</i>	Pompador Green Pigeon	R	P	
	<b>Psittaciformes: Psittacidae</b>				
23	<i>Psittacula krameri</i>	Rose-ringed Parakeet	R	P	27
24	<i>Psittacula cyanocephala</i>	Blossom-headed Parakeet	R	P	25
	<b>Cuculiformes: Cuculidae</b>				
25	<i>Clamator jacobinus</i>	Pied Crested Cuckoo	DM	I	36
26	<i>Hierococcyx varius</i>	Brainfever Bird	R	I	38
27	<i>Eudynamis scolopacea</i>	Asian Koel	R	P	16
28	<i>Phaenicophaeus viridirostris</i>	Small Green-billed Malkoha	R	C	32
29	<i>Centropus sinensis</i>	Greater Coucal	R	O	29
	<b>Strigiformes: Strigidae</b>				
30	<i>Athene brama</i>	Spotted Owlet	R	C	37
	<b>Apodiformes/ Apodidae</b>				
31	<i>Collocalia unicolor*</i>	Indian Edible-nest Swiftlet	R	I	16
32	<i>Cypsiurus balasensis</i>	Asian Palm Swift	R	I	14
33	<i>Apus affinis</i>	House Swift	R	I	9
	<b>Coraciiformes: Icedinidae</b>				
34	<i>Pelargopsis capensis*</i>	Stork-billed Kingfisher	R	C	38
35	<i>Halcyon smymensis</i>	White-breasted Kingfisher	R	C	23
36	<i>Ceryle rudis*</i>	Lesser Pied Kingfisher	R	C	38
	<b>Meropidae</b>				
37	<i>Merops orientalis</i>	Small Bee-eater	LM	I	19
38	<i>Merops philippinus</i>	Blue-tailed Bee-eater	LM	I	24

	Order/Family/species	Common name	Status	Feeding habit	Rank of Dominance (1-38)
	<b>Coraciidae</b>				
39	<i>Coracias benghalensis</i> *	Indian Roller	LM	C	38
	<b>Upupidae</b>				
40	<i>Upupa epops</i> *	Hoopoe	LM	I	30
	<b>Piciformes: Capitonidae</b>				
41	<i>Megalaima viridis</i>	White-cheeked Barbet	R	P	36
42	<i>Megalaima rubricapilla</i> *	Crimson-throated Barbet	R	P	37
	<b>Picidae</b>				
43	<i>Celeus brachyurus</i>	Rufous Woodpecker	R	I	37
44	<i>Dinopium javanense</i> *	Common Golden-backed Woodpecker	R	I	38
45	<i>Dinopium benghalense</i>	Lesser Golden-backed Woodpecker	R	I	38
	<b>Passeriformes: Alaudidae</b>				
46	<i>Mirafra cantillans</i> *	Singing Bush-Lark	R	P	37
47	<i>Mirafra erythroptera</i> *	Red-winged Bush-Lark	R	P	22
48	<i>Eremopterix grisea</i> *	Ashy-crowned Sparrow-Lark	R	P	26
49	<i>Galerida malabarica</i> *	Malabar Crested Lark	R	P	21
50	<i>Alauda gulgula</i> *	Eastern Skylark	R	P	29
	<b>Hirundinidae</b>				
51	<i>Hirundo rustica</i>	Common Swallow	LM	I	28
52	<i>Hirundo smithii</i>	Wire-tailed Swallow	R	I	23
53	<i>Hirundo daurica</i>	Red-rumped Swallow	R	I	20
	<b>Motacillidae</b>				
54	<i>Motacila alba</i> *	White Wagtail	LM	I	37
55	<i>Motacila maderaspatensis</i> *	Large Pied Wagtail	R	I	29
56	<i>Anthus rufulus</i> *	Paddyfield Pipit	R	I	14
57	<i>Anthus hodgsoni</i>	Oriental Tree Pipit	R	I	37
	<b>Campehagidae</b>				
58	<i>Coracina macei</i>	Large Cuckoo-Shrike	R	I	35
59	<i>Pericrocotus flammeus</i> *	Scarlet Minivet	R	I	38
60	<i>Pericrocotus ethologus</i> *	Long-tailed Minivet	LM	I	35
61	<i>Pericrocotus cinnamomeus</i> *	Small Minivet	R	I	37
	<b>Pycnonotidae</b>				
62	<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	R	O	5
63	<i>Pycnonotus cafer</i>	Red-vented Bulbul	R	O	16
64	<i>Pycnonotus xantholaemus</i> *	Yellow-throated Bulbul		I	33
65	<i>Pycnonotus luteolus</i>	White-browed Bulbul	R	P	7
66	<i>Lole indica</i> *	Yellow-browed Bulbul	R	P	37
	<b>Irenidae</b>				
67	<i>Aegithina tiphia</i> *	Common Iora	R	I	35
68	<i>Chloropsis aurifrons</i> *	Gold-fronted Chloropsis	R	I	39
69	<i>Chloropsis cochinchinensis</i> *	Jerdon's Chloropsis	R	I	28
	<b>Laniidae</b>				
70	<i>Lanius vittatus</i>	Bay-backed Shrike	LM	C	38
71	<i>Lanius schach</i>	Rufous-backed Shrike	LM	C	12
	<b>Muscicapidae</b>				
72	<i>Zoothera citrina</i>	Orange-headed Thrush	R	I	20
73	<i>Copsychus saularis</i>	Oriental Magpie-Robin	R	I	18
74	<i>Saxicoloides fulicata</i>	Indian Robin	R	I	4
75	<i>Saxicola torquata</i> *	Common Stonechat	R	I	36
76	<i>Saxicola caprata</i> *	Pied Bushchat	R	I	25

	Order/Family/species	Common name	Status	Feeding habit	Rank of Dominance (1-38)
77	<i>Prinia hodgsonii</i>	Franklin's Prinia	R	I	17
78	<i>Prinia socialis</i> *	Ashy Prinia	R	I	31
79	<i>Prinia inornata</i>	Plain Prinia	R	I	31
80	<i>Acrocephalus dumetorum</i> *	Blyth's Reed-Warbler	LM	I	31
81	<i>Hippolais caligata</i> *	Booted Warbler	DM	I	31
82	<i>Orthothomus sutorius</i>	Common Tailorbird	R	I	32
83	<i>Phylloscopus trochiloides</i> *	Greenish Leaf-Warbler	DM	I	37
84	<i>Sylvia curruca</i> *	Common Lesser White throat	DM	I	37
85	<i>Sylvia hortensis</i>	Orphean Warbler	DM	I	32
86	<i>Chrysomma sinense</i> *	Yellow-eyed Babbler	R	I	33
87	<i>Turdoides caudatus</i>	Common Babbler	R	P	25
88	<i>Turdoides subrufus</i> *	Indian Rufous Babbler	R	P	35
89	<i>Turdoides striatus</i>	Jungle Babbler	R	P	11
90	<i>Dumetia hyperythra</i>	Rufous-bellied Babbler	R	I	37
91	<i>Ficedula supercilii</i> *	Ultramarine Flycatcher	R	I	35
92	<i>Terpsiphone paradisi</i>	Asian Paradise-Flycatcher	R	I	37
	<b>Dicaeidae</b>				
93	<i>Dicaeum erythrorhynchos</i>	Tickell's Flowerpecker	R	P	37
94	<i>Dicaeum concolor</i> *	Plain Flowerpecker	R	P	36
	<b>Nectariniidae</b>				
95	<i>Nectarinia zeylonica</i>	Purple-rumped Sunbird	R	P	25
96	<i>Nectarinia minima</i> *	Small Sunbird	R	P	34
97	<i>Nectarinia asiatica</i>	Purple Sunbird	R	P	6
98	<i>Nectarinia lotenia</i> *	Loten's Sunbird	R	P	37
	<b>Estrildidae</b>				
99	<i>Lonchura striata</i>	White-rumped Munia	R	P	30
	<b>Passeridae</b>				
100	<i>Passer domesticus</i>	House Sparrow	R	O	21
101	<i>Petronia xanthocollis</i>	Yellow-throated Sparrow	R	O	37
102	<i>Ploceus philippinus</i>	Baya Weaver	R	P	29
	<b>Sturnidae</b>				
103	<i>Sturnus pagodarum</i> *	Brahminy Starling	R	O	38
104	<i>Sturnus roseus</i> *	Rosy Starling	DM	I	3
105	<i>Acridotheres fuscus</i>	Jungle Myna	R	O	2
	<b>Oriolidae</b>				
106	<i>Oriolus oriolus</i>	Eurasian Golden Oriole	LM	P	26
107	<i>Oriolus xanthornus</i>	Black-headed Oriole	R	P	26
	<b>Dicruridae</b>				
108	<i>Dicrurus macrocercus</i>	Black Drongo	R	C	15
109	<i>Dicrurus leucophaeus</i> *	Ashy Drongo	LM	C	33
110	<i>Dicrurus caerulescens</i>	White-bellied Drongo	LM	I	32
111	<i>Dicrurus paradiseus</i>	Greater Racket-tailed Drongo	R	I	38
	<b>Corvidae</b>				
112	<i>Dendrocitta vagabunda</i>	Indian Treepie	R	O	35
113	<i>Corvus splendens</i>	House Crow	R	O	1
114	<i>Corvus macrorhynchos</i>	Jungle Crow	R	O	25

Status: R - resident; LM - local migrant; DM - distant migrant.

Feeding habit: I - insectivore; C - carnivore; O - omnivore; P - phytophages

\* - Additional sightings. These birds were newly sighted during the current study and were not reported on the plateau by earlier reports/ papers cited in the communication.

Rank of dominance (1-38): The ranks are given based on the cumulative total of individuals of the respective species sighted during entire study period. The species with highest cumulative total is given rank 1 and so on.

wattled Lapwing were sighted in November. A nest of House Swifts was noticed at the corner of a ceiling. Two birds were seen ferrying food to the nest, and a pure white, oval-shaped egg 2cm in length was also found fallen on the ground at the site.

**Winter (December–February):** The atmospheric temperature ranged between 19.8 and 32.3 °C. The humidity was about 80%.

The ground level herbaceous greenery was nonexistent. All the shrub species that flowered in the post-monsoons were in fruition during the season. The tree species in bloom were *P. pterocarpum*, *Butea monosperma*, *B. ceiba*, *P. dulce* and *A. occidentale*.

Bird abundance was highest during winter, compared to that of other seasons, of the 59 avian species 11 were migrants. The migrant species formed 25% of the population during the season. Besides the residents, two prominent winter visitors to the region were the Eurasian migrant, Rosy Starling and a local migrant, Common Swallow. The Rosy Starlings arrived in January in large flocks. They were found generally on the Red Silk Cotton Tree, *B. ceiba*, noisily and restlessly feeding on the insects associated with the red flowers of the deciduous tree in bloom. The other birds found in association with Rosy Starlings on *B. ceiba* were Black Drongo, House Crow, Jungle Myna and Asian Koel. The Asian Koels were found feeding on the dehiscent fruits of *P. dulce*. Other birds that shared the fruits of the tree were White-browed Bulbul, Black-headed Oriole, Jungle Myna and House Crow. The sunbirds were found feeding on the blooms of *A. occidentale* and also on the flowers of *Calotropis gigantea*. Insectivorous guild was predominant during winter accounting for 47% of the total population. Breeding activities of the House Crow were observed during the season with sightings of eight nests on *B. ceiba* and *C. litorea*. An active nest (18x6 cm) with an entrance of 5cm diameter of the White-rumped Munia was sighted anchored on *Bougainvillea* sp. besides an abandoned old nest. The parent ferrying the feed was seen and soliciting calls of the nestlings were heard.

**Summer (March–May):** The atmospheric temperature during summer ranged from 22.3 to 33.2 °C. Relative humidity on an average was 80%.

*Mimusops elengi* and *Ixora coccinia* were flowering. The plant species in bloom during the preceding season were laden with fruits. Bird diversity was higher but abundance was lower compared to winter.

Bird fauna was constituted by 69 species. Almost 1/6<sup>th</sup> of the population was formed by 10 migratory species, prominent ones being distant migrant Rosy Starling till the early part of summer and the large flocks of the local migrant, Common Swallow till mid summer. But by May all the migrants had left the area, and also the few residents such as Wire-tailed Swallow, House Swift, Indian Treepie and Plum-headed Parakeet were not to be sighted. During summer, compared to winter, the insectivores though reduced in strength maintained their supremacy marginally, with 42% share. *Z. rugosa*, a fairly common shrub in the area with large panicles of fleshy berries hosted all the local species of bulbuls, Asian Koel, Plum-headed Parakeet and Rosy Starlings. *L. camara* and *M. paniculata* were the other two shrubs with fruits in the season that catered to the needs of the bulbuls.

During the season, two nests of Indian Robin were sighted; one of them was on the ground and the other in the hollow of an angular pipe 1.5m above the ground. Two eggs each were found in them. Two cup-shaped nests of Red-whiskered Bulbul and one of Red-vented Bulbul were found in the thickets at a height of 5m from the ground. A nest each of Red-wattled and Yellow-wattled Lapwing with three eggs in each were found on open barren land encircled by pebbles. A purse shaped deserted nest of a sunbird was also found.

**Monsoon (June–September):** Rainfall during the season was 1948mm. Showers were heavy in July (832mm). Wind speed varied from 9 to 33 km/hr. Atmospheric temperature ranged from 22.3 to 33.2 °C. Average humidity was 91%.

Grasses *T. triandra* and *A. mutica*; and trees *P. ferrugineum* and *A. auriculiformis* were in bloom. *I. coccinea* was laden with fruits. *L. camara* bore flowers and fruits throughout the year.

**Table 2. Seasonal variation in the number of species and population of resident and migrant birds using Kruskal-Wallis test.**

Birds	Df	c <sup>2</sup>	p
Migratory species	3	8.00	0.05*
Migratory population	3	6.19	0.10
Resident species	3	2.35	0.50
Resident population	3	4.36	0.22

\* statistically significant

**Table 3. Seasonal variations in the population of birds belonging to different feeding-guilds using Kruskal-Wallis test.**

Feeding guilds	df	c <sup>2</sup>	p
Insectivores	3	9.15	0.03*
Carnivores	3	2.06	0.56
Omnivores	3	0.32	1.0
Phytophagous	3	5.47	0.14

\* statistically significant

The bird population was the least, but was constituted by 72 species, that included six migratory ones. The species composition was highest compared with those of other seasons. The only monsoon migrant to the campus was Pied Crested Cuckoo. The other five species were early arrivals of winter migrants sighted in September, such as the Small Bee-eater, Rufous-backed Shrike, White-bellied Drongo, Blyth's Reed Warbler and Orphean Warbler. During the season common resident birds such as Jungle Myna, Red-wattled Lapwing, Indian Robin and House Crows were found in large numbers. A good number of Common Peafowl were sighted. The three major feeding guilds, insectivores, phytophages and also omnivores were nearly equal in proportion, ranging from 29 to 36 percent. The Rufous-backed Shrike, a local migrant which spent the maximum time in the area was prominent by its absence during the season.

Pond Heron, Cattle Egret, Common Sandpiper and Terek Sandpiper were the only wetland birds on the campus.

**Seasonality:** The resident birds on the whole did not show any statistically significant variations through the seasons in terms of species or population (Table 2). The migrant species were significantly less during the monsoon ( $c^2=8$ ,  $df=3$ ,  $p=0.05$ ). The species similarity/dissimilarity indices led to a close clustering of winter and summer with a relatively high similarity coefficient of 0.78. Monsoon and post-monsoon seasons grouped with the cluster at the level of 0.75 and 0.69 respectively. None of the clustering was statistically significant.

The populations of omnivores, carnivores and phytophages did not vary significantly through the seasons (Table 3). The population of insectivores, however, increased significantly during winter and summer ( $c^2=9.15$ ,  $df=3$ ,  $p=0.03$ ) as compared to those

of the monsoon and post monsoon periods. However, there was no significant seasonal difference in bird diversity belonging to different feeding guilds.

## DISCUSSION

### Composition and Diversity of Avifauna

One-hundred-and-fourteen species of birds sighted in the area forming 37% of the bird species on record for the state (Lainer 2005), is an appreciable diversity emphasizing the richness of the plateau on the outskirts of a bustling capital city, already under substantial anthropogenic pressure. Only four wetland bird species were sighted in the study area. Two of them, the Pond Heron and Cattle Egret are 'not completely dependent' wetland species (Vijayan 1986). The other two, the Common Sandpiper and Terek Sandpiper might be vagrants from the floodplains of rivers in the vicinity. Nearly half of the species currently recorded for the plateau, numbering 53, are new additions to the checklist of the area over the earlier reports (Shanbhag & Gramopadhye 1993; Shyama & Gowthaman 1995). Forty-five of them were relatively scarce with dominance ranks below 30, with only less than 15 sightings across the year. Some other species like those of larks and pipits with good camouflage were likely to be missed in less intensive surveys. The Rosy Starling, the only prominent distant migrant visiting the area in good numbers must have escaped the previous surveys, as one of them (Shanbhag & Gramopadhye 1993) was a preliminary report and the other (Shyama & Gowthaman 1995) was presumably a short duration opportunistic survey. Therefore, to have a complete picture of avifauna of any site, an intensive study needs to be carried out for at least a year. At the same time, despite the intensive survey conducted during the present study, the failure to site species like Malabar Pied Hornbill and Indian Grey Hornbill reported earlier (Shanbhag & Gramopadhye 1993) could be due to increased anthropogenic indulgence and habitat deterioration, as the species in question are natural denizens of undisturbed woods.

### Dominance and seasonality

The House crow and Jungle Myna, the omnivores dominated the plateau in terms of their population. In view of the continuous anthropogenic pressure on the



plateau, the phenomenon is in full consonance with the principle that the habitat generalists thrive well in disturbed areas (Kwok & Corlett 1999).

Rosy Starling, a Eurasian migrant was one of the dominant bird species on the plateau. The species was neither sighted in the natural forest nor the forest plantations during one of our extensive studies in the region (Desai 2005). Therefore, it is obvious that this migrant prefers scrublands/plateaux rather than forests. Their arrival coincided with the flowering of *B. ceiba*, one of the dominant tree species of the plateau with which they were always found associated.

Five species of larks, the grassland specialists were recorded on the plateau. The peak fruiting season of grasses attracted the maximum number of granivores to the region. As the grasslands cater to the needs of habitat specialist birds, decrease in its extent on the plateaux either due to increased masonry or afforestation may turn out to be a threat to these species.

Neither the number of species nor the cumulative population of residents in the area varied through the seasons. Structurally complex vegetation types are known to buffer the effects of seasonality (Janzen 1967). This amelioration of physical environment is supposed to result in greater stability in resource availability (Janzen 1967; Smythe 1974) thereby allowing more species to occur (MacArthur 1972) as residents throughout the year. On the plateau under study the vegetation was of a wide spectrum consisting of ephemeral herbs, and a variety of shrubs and trees. They were in bloom during various seasons bearing fleshy and dehiscent edible fruits. Thus, the habitat can be considered to be bestowed with complex vegetation, hence capable of nurturing a stable bird population.

During the monsoon, migratory bird population dropped significantly as the Pied Crested Cuckoo was the only principal migrant of the season to the plateau. Other migrants were winter migrants that started arriving in the post-monsoons and stayed back till the beginning or mid summer.

The prominence of insectivores during winter and summer could primarily be due to the inflow of migrants like Rosy Starlings, bee-eaters and Common Swallow, besides the insectivorous resident species. During the seasons the plants like *F. benghalensis*, *A. occidentale*, *Z. mauritiana*, *Z. rugosa*, and *Securinega*

*virosa* were in extensive bloom and bore fleshy fruits. On the other hand, trees like *B. ceiba*, *Peltophorum pterocarpum* and *A. auriculiformis*, though with dry non-edible fruits, were with flowers of bright colours and good quantity of nectar. These factors on the whole might be responsible for augmenting insect prey resource during these seasons and the resultant rise in the insectivorous bird population.

The campus supported breeding activities of at least 10 bird species belonging to diverse feeding guilds. Among these the House Crow was the most successful breeding species. The presence of an old nest of White-rumped Munia, besides the active nest on the same tree indicates that the bird used the site for nesting year after year. Earlier reports (Sadh 1999) from our laboratory corroborating with the present findings indicate that the plateau with open sun-baked areas must be a traditional breeding ground of Red-wattled Lapwings as well as Yellow-wattled Lapwings.

## CONCLUSIONS

The current trend in the region to encroach on plateau after plateau for mega projects doesn't augur well for the conservation of biodiversity. Before it is too late, there is a need for identifying a reasonable number of plateaux in the region as protected sites and systematic studies on their flora and fauna carried out, such that the original lateritic mosaic with grassland patches and indigenous trees are left intact.

Open areas with herbaceous vegetation and grasses, many of them being endemic are characteristic features of the lateritic plateaux. These open areas are of utmost importance for the bird population as they provide better visibility for vigilance from their predators and free movement towards food procurement. Therefore, the extensive afforestation programmes in these open grassland areas are to be discouraged as they might do away with native and endemic herbaceous vegetation because of their canopy cover. Even if afforestation with tree species is felt necessary it should be done in isolated patches/islands without interfering with the open areas on a large scale.

The use of exotic tree species such as Australian acacia in such afforestation programmes is anathema, as they may not serve as good hosts to indigenous

insect species and in turn not meet the requirements of insectivorous and frugivorous birds changing the microclimates of specialized flora and fauna as reported earlier (Watve 2003).

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