

A comparative study of mixed-species bird flocks in shaded coffee plantation and natural forest in Wayanad, Kerala

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Abstract

Mixed-species flocks, in two different habitats (coffee plantation and natural forest) in Wayanad District, were studied in order to compare the species composition and organisation of flocks in both habitats. Flocks were surveyed along three 500 m trails at the study sites and species, species numbers, number of individuals, and the foraging height and foraging substrate of species within the flocks were recorded. A total of 38 flocks were observed in the coffee plantation and 25 flocks in the natural forest. The results suggested no significant differences in the abundance of mixed-species flocks, mean species richness, or mean number of individuals per flock. However, there was a change in the foraging levels of certain species from mid-canopy/upper canopy in coffee plantation to lower canopy/understorey levels in forest. The foraging height of the flock members differed significantly between both habitats. The organisation of species within flocks differed in both habitats, although species composition remained almost similar. Finally, flocks with White-bellied Treepie, Dark-fronted Babbler, Indian Scimitar Babbler, White-bellied Blue Flycatcher, Puff-throated Babbler and Malabar Trogon were unique to the natural forest habitat. Some of the Western Ghats endemic species were found only in flocks found in forest habitat, which highlights the vital importance of natural forests in supporting endemic species.

Introduction

Multi-species associations are common in almost all animal taxa; mixed-species bird flocks being the most widespread, and the most commonly studied. Mixed-species flocks are roving groups of two or more species found actively foraging in an area at a particular time and moving in the same direction in a co-ordinated manner (Sridhar *et al.* 2009). Flocking has evolved as a mechanism to increase foraging efficiency and to reduce predation risk (Grubb 1987; Jullien & Thiollay 1998; Thiollay 1999). For instance, birds within a flock gain foraging benefits through feeding on insects flushed by other members, by copying foraging locations and foraging manoeuvres used by other active foragers or by avoiding sites/areas that had already been foraged upon by others (Zuluaga & Jaime 2013). At the same time, flock members can also face simultaneous costs. For example, the Greater Racket-tailed Drongo *Dicrurus paradiseus* has been reported to kleptoparasitise other species in flocks (King & Rappole 2001). However, these drongos also play an important role as sentinels, by giving reliable alarm calls, thus alerting other species about the movements of predators (Kotagama & Goodale 2004; Goodale & Kotagama 2005b).

Although various ecological aspects of mixed-species flocks have been studied throughout the world (Munn & Terborgh 1979; Berner & Grubb 1985; Peron & Crochet 2009; Sridhar & Shanker 2014a,b), comparative studies on flocks across natural and human-altered landscapes in the Western Ghats are few, and coffee plantation, being a dominant human land-use in the Western Ghats forests have also received scant interest (Sidhu *et al.* 2011). This paper compares mixed-species bird flocks in a coffee plantation with those in a natural forest.

Study area

The study was carried out in Wayanad District, north-eastern Kerala. Two study areas were chosen in the South Wayanad region. One was a tropical wet evergreen forest in Thalipuzha, Lakkidi (11.52°N, 76.03°E; c. 700 m asl). The second, a coffee plantation (11.54°N, 76.02 E, c. 700 m asl) within the campus of the Kerala Veterinary and Animal Sciences University, Pookode [90, 91]. Both the study sites fall in the same rainfall zone, Vythiri, and receive an average annual rainfall of 395 cm (Simon & Mohankumar 2004). The climate is generally wet and cold throughout the year with an annual average temperature of 23°C.



90. Natural forest habitat at Thalipuzha (Lakkidi)



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91. Coffee plantation in Pookode

Materials & methods

This study was conducted from February to June 2015. The study areas were sampled using three 500 m long trails. Data were collected by walking along these trails and searching for flocks. Observations were carried out for two hours each, in the morning between 0630 and 1130 hrs, as well as the afternoon/evening between 1400 and 1800 hrs. Each trail was surveyed ten times (i.e., a total of 30 trail surveys each in both habitats). Thus, a total of 60 hours of observations were logged on both the forest and coffee plantation trails.

Following Stotz (1993), flocks were defined as roving associations of two or more species staying together for at least five minutes. A bird found within ten meters of another individual bird was considered to be a member of a flock (Sridhar *et al.* 2014a). When a flock was spotted, it was observed until all necessary data (number of species, number of individuals per species, foraging height, and foraging substrate) were recorded. Data collection started only five minutes after a flock was sighted. Precaution was taken to avoid double counting of flocks/individuals in a flock in such a way that once the necessary data from a flock were recorded, the next observation was taken only for those flocks which were at least 100 m away from the previous one. Olympus 8x40 DPS-I binoculars were used to observe birds in the field. Photographs were taken of species that could not be identified in the field, using Canon Powershot SX510HS, and Canon 60D with Canon 55–250 mm IS lens. Dominant tree species of the area were noted and the canopy cover was measured every 100 m on each of the trails, using a spherical densiometer.

Independent sample *t*-tests¹ were done to check for significant differences in the mean species richness and mean number of individuals per flock in both habitats. These tests were done using SPSS (version 16.0) (Sidhu *et al.* 2011). Further, we did a Non-Metric Multidimensional Scaling Analysis (*henceforth*, NMDS) using PAST, ver.2.16 (Hammer *et al.* 2001) to look at similarity between flocks in different habitats.

Results

The two habitats differed in terms of tree diversity and overall

¹ A *t*-test is done to determine whether the mean of a population differs significantly from a specific value or from the mean of another population and the *t*-test value measures the size of the difference relative to the variation in the sample data.

Table 1. Tree species found in natural forest and coffee plantation, in decreasing order of abundance.

Natural forest	Coffee plantation
<i>Cinnamomum malabatum</i>	<i>Spathodea campanulata</i>
<i>Holigarna arnottiana</i>	<i>Cinnamomum malabathrum</i>
<i>Vateria indica</i>	<i>Elaeocarpus tuberculatus</i>
<i>Elaeocarpus tuberculatus</i>	<i>Erythrina indica</i>
<i>Syzygium cumini</i>	<i>Alstonia scholaris</i>
<i>Antidesma monatanum</i>	<i>Ficus</i> sp.
<i>Mesua ferrea</i>	<i>Syzygium caryophyllatum</i>
<i>Artocarpus heterophyllus</i>	<i>Careya arborea</i>
<i>Artocarpus hirsutus</i>	<i>Mangifera indica</i>
<i>Myristica beddomei</i>	<i>Artocarpus heterophyllus</i>
<i>Mangifera indica</i>	<i>Artocarpus hirsutus</i>
<i>Ailanthus triphysa</i>	<i>Holigarna arnottiana</i>
<i>Dipterocarpus indicus</i>	<i>Dalbergia latifolia</i>
<i>Erythrina indica</i>	<i>Lagerstroemia lanceolata</i>
<i>Polyalthia coffeoides</i>	<i>Albizia saman</i>

canopy cover. The climate and rainfall in the two study areas are similar. The mean canopy cover of the forest habitat (90.28%) was greater than that of the coffee plantation (76.98%).

Apart from the tree species found in the forest habitat (Table 1), palms like *Arenga wightii*, *Caryota urens*, *Pinanga dicksonii*, *etc.*, and *Ochlandra* sp., of bamboo were also found. A small portion of the forest, which had been cleared for *Eucalyptus* sp., plantations, was now characterised by an abundant secondary growth of native species. Canopy trees are mostly *Eucalyptus* sp., and the lower canopy trees include *Erythrina indica*, *Macaranga peltata*, *Psidium guajava*, *Symplocos cochinchinensis*, *etc.*

The plantation includes arecanut, plantains, and pepper, along with coffee as the major crop. Trees such as rosewood, *Artocarpus* sp., *Erythrina indica*, and other species have been preserved in plantations to provide shade to the coffee plants. Dominant tree species found in the coffee plantation are listed in Table 1. Two of the three trails in the plantation had arecanut plantations interspersed with coffee *Coffea robusta*.

Bird flocks in coffee plantation and forest

Overall, 498 individuals belonging to 74 bird species were recorded during the study period from the two study sites. A total of 38 flocks were encountered in the coffee plantation, and 25 in forest, after 60 hours of observation in each habitat.

Species richness and abundance in flocks

The mean number of species and individuals in both habitats are given in Table 2. On comparing the abundance and size of flocks in both habitats, it was clear that there was not much difference in the mean species richness or mean number of individuals per flock. An independent sample *t*-test indicated that the mean species richness of flocks did not differ significantly between both the habitats ($t_{61} = 0.37$; $p = 0.71$). There was no significant difference in the mean number of individuals per flock between both habitats ($t_{61} = 0.76$; $p = 0.45$).

Table 2. Mean values for number of species, individuals, and foraging height of flocking species in natural forest and coffee plantation.

Category	Mean±SD [Min-Max]	
	Natural Forest	Coffee Plantation
Number of species	7.68±4.03 [4-20]	8.03±3.36 [3-16]
Number of individuals	17.52±10.21 [6-47]	19.55±10.49 [5-46]
Foraging height	6.64±2.27	7.29±2.72

Table 3. List of ten most frequently seen flocking birds in two different habitat types.

Coffee plantation			Forest habitat		
Species (52)	Feeding guild	Flocks (38)	Species (44)	Feeding guild	Flocks (25)
Scarlet Minivet <i>P. f. flammeus</i>	INS	24	Scarlet Minivet <i>P. f. flammeus</i>	INS	18
White-cheeked Barbet <i>Psilopogon viridis</i>	FRU	23	Yellow-browed Bulbul <i>A. indica</i>	FRU	18
Red-whiskered Bulbul <i>Pycnonotus jocosus</i>	FRU	22	Racket-tailed Drongo <i>D. paradiseus</i>	INS	15
Bronzed Drongo <i>D. aeneus</i>	INS	19	White-cheeked Barbet <i>P. viridis</i>	FRU	15
Yellow-browed Bulbul <i>Acritillas indica</i>	FRU	18	Bronzed Drongo <i>D. aeneus</i>	INS	12
Velvet-fronted Nuthatch <i>Sitta frontalis</i>	INS	15	White-bellied Treepie <i>Dendrocitta leucogastra</i>	OMN	12
Indian Black-lored Tit <i>Machlolophus xanthogenys</i>	INS	15	Velvet-fronted Nuthatch <i>S. frontalis</i>	INS	9
Pale-billed Flowerpecker <i>Dicaeum erythrorhynchos</i>	FRU	12	Red-whiskered Bulbul <i>P. jocosus</i>	FRU	7
Racket-tailed Drongo <i>D. paradiseus</i>	INS	12	Flame-throated Bulbul <i>P. melanicterus</i>	FRU	6
Oriental White-eye <i>Zosterops palpebrosus</i>	NEC	11	Brown-cheeked Fulvetta <i>Alcippe poioicephala</i>	INS	5

FRU- Frugivore; INS-Insectivore; NEC- Nectarivore; OMN- Omnivore

Species composition & organisation in coffee plantation

A total of 52 species were found to participate in mixed-species flocks in the coffee plantation. The most frequently flocking species, which were present in roughly half of the total flocks (38 flocks) of the area, are listed in Table 3.

Species composition & organisation in forest

Of the 44 flocking species found in forests, ten species were listed as frequently flocking species, which were found in almost half of the flocks encountered (see Table 3). Apart from these, Red-whiskered Bulbul *P. jocosus*, Flame-throated Bulbul *P. melanicterus*, Brown-cheeked Fulvetta *A. poioicephala*, Indian Black-lored Tit *M. xanthogenys*, Nilgiri Flowerpecker *D. concolor*, Pale-billed Flowerpecker *D. erythrorhynchos*, Greater Golden-backed Woodpecker *Chrysocolaptes lucidus*, and Speckled Piculet *Picumnus innominatus* were also found in forest flocks. Dark-fronted Babbler *Rhopocichla atriceps*, Indian Scimitar Babbler *Pomatorhinus horsfieldii*, Puff-throated Babbler *Pellorneum ruficeps*, Malabar Trogon *Harpactes fasciatus*, White-bellied Blue Flycatcher *Cyornis pallidipes*, White-bellied Treepie *D. leucogastra*, and Orange-headed thrush *Geokichla citrina* were recorded only in forest flocks.

Flock composition between habitats

Flock composition differed between coffee plantation and natural forest, though the size and species richness did not show significant differences. Bird communities in two different habitats formed a unique cluster in an NMDS plot (Fig. 1).

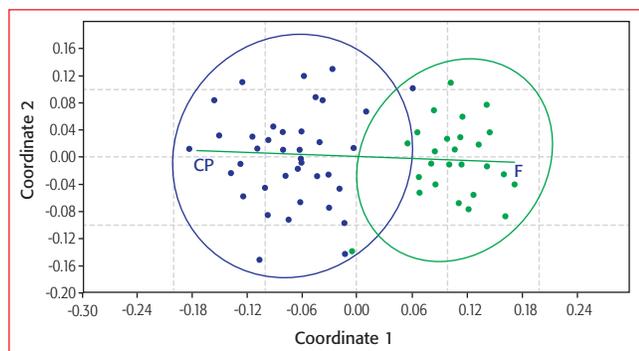


Fig. 1. Non-metric Multidimensional Scaling ordination (NMDS) of bird flocks in two different habitats. CP=coffee plantation; F=Forest.

Flock size & composition

The species composition of flocks in both habitats was more or less similar (Table 3) except for species such as Indian Scimitar Babbler, Dark-fronted Babbler, Puff-throated Babbler, Malabar Trogon, and Orange-headed thrush, and Western Ghats endemics such as White-bellied Treepie and White-bellied Blue Flycatcher, which were missing in flocks in coffee plantation. Seven species of the family Picidae (Woodpeckers and Piculets) were observed at least once in the coffee plantation flocks. Woodpeckers that were found to be quite active within the flocks were Greater Golden-backed Woodpecker, Lesser Golden-backed Woodpecker *Dinopium benghalense*, Speckled Piculet, Brown-capped Pygmy Woodpecker *Dendrocopos moluccensis*, Rufous Woodpecker *Micropternus brachyurus*, Heart-spotted Woodpecker *Hemicircus canente*, and Lesser Yellow-naped Woodpecker *Picus chlorolophus*. The woodpecker species were mostly seen interacting with barbets, Greater Racket-tailed Drongos, Southern Hill Mynas *Gracula religiosa*, and Scarlet Minivets (Orange Minivet) *Pericrocotus f. flammeus* that were found within the same flocks. It is also important to mention about winter visitors such as the Indian Golden Oriole *Oriolus kundoo* and Verditer Flycatcher *Eumyias thalassinus*, who were highly active within flocks during February–March, but were not observed during the rest of the study period. Some of the frugivores were also found to be active participants in mixed-species flocks in the plantation area. The White-cheeked Barbet was very common and was found in the majority of the flocks, actively foraging and moving about within them. More than five individuals of the Grey-fronted Green Pigeon were observed within two different flocks in the coffee plantation, where they were found foraging together with flowerpeckers, minivets, Common Ioras *Aegithina tiphia*, Red-whiskered Bulbuls, Vernal Hanging Parrots, White-cheeked Barbets, and Bronzed Drongos.

Foraging height

The mean foraging height of species in flocks in the coffee plantation, and in natural forest was significantly different (see Table 2).

Frequently flocking species and their feeding guilds

Guild associations of the ten most frequently flocking species in coffee and forest habitats are given below (Fig. 2). There were two dominant groups, insectivores, and frugivores (De Graaf *et al.* 1985; Sasikumar *et al.* 2011). There was only one each of a nectarivore and omnivore in the group, the Oriental White-eye,

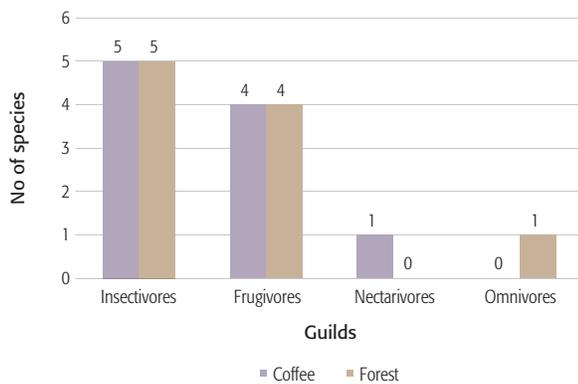


Fig. 2. Feeding guilds of frequently flocking species of two habitats

and the White-bellied Treepie. The insectivore group, by itself, is diverse, foraging at different strata such as foliage insectivores, bark gleaners, and sallying insectivores (De Graaf *et al.* 1985). The guild structure of frequently flocking species in forest and coffee plantations is such that each has four different guilds. But the understorey insectivores are missing in the coffee plantation due to its structural difference; whereas in forest flocks, this stratum is represented by Brown-cheeked Fulvetta and, in addition, the presence of the omnivorous White-bellied Treepie. Ali & Ripley (1986) described the latter as a “regular member of itinerant commensal parties of assorted insectivorous birds.” A true understorey layer, which is often characterised by high insect- and other small animal-life, is lacking in the coffee plantation, which might have kept away these species from flocking in coffee.

Endemic birds in flocks

We recorded 11 endemic species during the study of which eight were found in forest areas, and nine in coffee plantations (Table 4). Two species of endemics found in forest areas are not found in coffee plantation. One of them is the White-bellied Blue Flycatcher, a mid-storey insectivore, and the other, the White-bellied Treepie.

Discussion

Our study shows that diversity of mixed-species flocks varied between shaded coffee plantation and natural forest. The results showed that there were 38 observations of mixed-species flocks

in the coffee plantation and 25 in forest, despite the same sampling effort in both habitats. However, statistical analyses showed that there was no significant difference in flock size in both the habitats despite differences in canopy cover. We recorded 58 species in the coffee plantation, of which 52 were frequently seen flocking in this area. Whereas, of the 47 bird species of the forest area under study, around 44 were observed in flocks. Sidhu *et al.* (2011) had studied composition of bird flocks in human-altered landscapes (tea, coffee, cardamom, and teak plantations) and observed that mixed-species flocks were absent in extremely altered habitats such as tea, when compared to natural forests, cardamom, and coffee. Their results also showed that coffee plantations supported a greater proportion of rainforest species than teak plantations. This result was supported by various studies (Thiollay 1995; Greenberg *et al.* 1997), showing that a mix of cultivated and native shade trees support more forest species.

An earlier study (Vishnudas 2008), in the same region as our study, found that *Crematogaster sp.*, ants in the shaded coffee plantations are a critical food source for Rufous Woodpecker and other birds. There have been studies comparing bird communities between human-altered landscapes and natural forests (Ohno & Ishida 1997; Round *et al.* 2006) that concluded that species richness in flocks decreased in agro-forests or plantations. Unlike those observations, our study showed that there were no significant differences in mean species richness and number of individuals per flock between the two habitats in this part of Wayanad.

The heights at which the flock members foraged differed significantly in both habitats. However, identifying and quantifying the factors that may have influenced foraging height selection were beyond the scope of this study. Although overall species composition was similar for both habitats, differences in the structure and organisation of species within a flock were noted. Species such as White-cheeked Barbet, Greater Golden-backed Woodpecker, Greater Racket-tailed Drongo, Yellow-browed Bulbul, and Indian Black-lored Tit, which used the mid-canopy to upper canopy foraging levels in coffee plantations, were found mostly in the lower canopy to understorey levels in the forest. However, since the flock members were distributed uniformly from the canopy level to the understorey level in the coffee plantation, it could indicate that coffee plantation might support more homogenous flocks when compared to forest where usually well-separated canopy and understorey flocks occur. The foraging levels of species mostly attribute to the prey/food abundance, but this could also be influenced by the presence/activity of fellow flock members. Studies have shown examples of birds adjusting/shifting their foraging perches, or substrates, according to habitats as well as their flock members (Robin & Davidar 2003). Another study also mentioned birds adjusting their perches according to the foraging heights of nuclear species of the flocks, thereby increasing the niche overlap between them (Hsieh & Chen 2011). Also, the vegetation structure between coffee plantation and forest differs considerably. A mid-storey is usually absent in coffee, and the understorey comprises a single species. These could be possible reasons for the difference in foraging height seen in this study as well. Species composition of flocks may be dependent on the tree species and canopy cover of the area. However, detailed observation of the tree species used by the flocking species could not be made due to logistical constraints.

Most of the species found within flocks were major insectivores that were occasional frugivores as well. This can be taken as an indication that the habitat supports a healthy prey/

Table 4. Endemic birds found in flocks of forest habitat and coffee plantation

Endemics	Forest	Coffee plantation
Malabar Starling* <i>Sturnia malabarica</i>		X
Crimson-backed Sunbird <i>Leptocoma minima</i>		X
Flame-throated Bulbul <i>P. melanicterus</i>	x	X
Grey-fronted Green Pigeon <i>Treron pompadora</i>		X
Malabar Barbet <i>P. malabaricus</i>	x	X
Malabar Grey Hornbill <i>Ocyrceros griseus</i>	x	X
Malabar Parakeet <i>Psittacula columboides</i>	x	X
Nilgiri Flowerpecker <i>D. concolor</i>	x	X
Rufous Babbler <i>Argya subrufa</i>		X
White-bellied Blue Flycatcher <i>C. pallidipes</i>	x	
White-bellied Treepie <i>D. leucogastra</i>	x	

* Though Praveen *et al.* (2018) do not treat this species as an endemic, it is well-accepted that this taxon is endemic and distinctly identifiable from the wintering nominate.

insect abundance. Despite being dominantly frugivores, some species like the White-cheeked Barbet and Grey-fronted Green Pigeon were observed to be actively participating in mixed-species flocks.

The majority of the forest flocks comprised species that were found in the plantation as well, except White-bellied Treepie, Indian Scimitar Babbler, Dark-fronted Babbler, Puff-throated Babbler, Malabar Trogon, Orange-headed thrush, and White-bellied Blue Flycatcher. We may have missed spotting some forest bird species due to the low visibility in the thick vegetation growth. Although many endemics were seen in both habitats, some (White-bellied Treepie, White-bellied Blue Flycatcher) were found only in flocks of forest habitat. This suggests that natural forests need to be protected in order to conserve such habitat sensitive endemics. Our study also shows that shaded coffee plantations are an important habitat for mixed-species flocks, and their proper management will enhance the biodiversity conservation potential of the farmlands. However, the fact that natural forests protect interactions between species of particular conservation concern, e.g., endemics, is a powerful argument for their protection.

Conclusion

On comparing species composition and organisation of flocks in both habitats, it can be concluded that the flocks of the coffee plantation and the forest habitat remained similar in terms of species composition and flock size but differed in parameters such as foraging height of species, species organisation within flocks, and flock structure. Moreover, statistical analyses showed that there were no significant differences in flock abundance, mean species richness, and mean number of individuals per flock across both habitats. The coffee plantation has maintained many shade trees and this gave ample opportunities for birds to forage. Further detailed studies are necessary to look into the dynamics of mixed-species flocks, and to understand their complex network of interspecific and intraspecific interactions. However, our study shows that coffee plantations, with sufficient tree coverage, provide excellent habitat for many birds and even mixed-species flocks, and proper agro-ecological management practices in coffee plantations will enhance their biodiversity value.

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Notes on field identification, vocalisation, status, and distribution of Large Blue Flycatcher *Cyornis magnirostris* and Hill Blue Flycatcher *Cyornis banyumas whitei* in north-eastern India

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Introduction

The flycatcher genus *Cyornis*, a grouping of closely related 'blue flycatchers', is represented in north-eastern India by six species (Kazmierczak 2000; Grimmett *et al.* 2011; Rasmussen & Anderton 2012; Praveen *et al.* 2018): Pale Blue- *C. unicolour*, Hill Blue- *C. banyumas*, Large Blue- *C. magnirostris*, Blue-throated- *C. rubeculoides*, White-tailed- *C. concretus*, and Pale-chinned Flycatchers *C. poliogenys*. Of these, the Hill Blue- and the Large Blue Flycatchers are superficially similar, and their status and distribution in the region remains poorly understood due to their apparent rarity, and difficulty in detection and identification, in addition to inconsistent taxonomy (Stresemann 1925; Robinson & Kinnear 1928; Rasmussen & Anderton 2012; Wells 2007).

In this note we present some insights on the identification, distribution, and status of these two puzzling taxa, from the result of field observations in recent years.

Methods

We use a combination of authors' field observations, re-verification of selected private and public observations (trip reports, social media, eBird), and a tallying of known specimens to understand the current distribution and status of both the taxa. The re-verification effort specifically questioned an observer on the approximate location of the record, date, and whether the species was confirmed by its vocalisation, or by plumage alone. The record was considered for our study only if its identification