BVG Trust

J. Sci. Trans. Environ. Technov. 2015, 8(4) : 189-194

Scientific Transactions in Environment and Technovation

Resource partitioning among three insectivorous birds in a portion of Cauvery deltaic region, Tamil Nadu

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Abstract

The present work describes the pattern of resource partitioning among three insectivorous birds namely small Green Bee-eater (*Merops orientalis*), Black Drongo (*Dicrurus adsimilis*) and Blue jay (*Coracias benghalensis*) . Analysis of 10 perch variables indicated that each species got separated from the other by one or two variables as supported by Principal component analysis.

Key words: *Coracias benghalensis, Dicrurus adsimilis, Merops orientalis,* perch variables Resource partitioning

INTRODUCTION

The significance of insectivorous birds as bio-control agents of agricultural pests has received greater attention in the recent years (Daniels, 1991). An advantage of studying guilds include directing attention towards all species regardless of taxonomic similarity, and defining as to which set of conditions are necessary for a particular group of species to exist in a habitat type. The small Green Bee- eater belongs to the fly catching guild and the other prominent members of this guild at the study area were the Black Drongo (*Dicrurus adsimilis* and the Blue jay (*Coracias benghalensis)*. As such any meaningful assessment of its foraging ecology should include a comparison with its co guild members of the fly catching guild in the study area. Further it would help us to understand the basis of niche separation among three species of the birds cited above.

STUDY AREA

The present study was carried out in an area of 150 sq km in and around Mannampandal , Mayiladuthurai, 11° 18′ N; latitude ,7950′ E longitude , in the Cauvery delta of Tamil Nadu, India. The area is dominated by wet agricultural lands with paddy being the predominant cultivated crop. Other crops such as sugarcane, ground nut, plantain, other cereals and pulses were also cultivated. Four seasons could be recognized based on rainfall namely Monsoon (October to December); Post -monsoon (January to March), Summer (April to June) and Pre monsoon (July to September). North east monsoon normally brings heavy rain, contributing more than 60% of the annual rainfall to the study area and is the deciding factor of the nature and extent of various seasons.

MATRILS AND METHODS

Foraging behavior of birds

Perch types: The perch types of the birds were categorized as electric wires/ telegraphic wires, walls, trees, shrubs and others which included sticks and mounds above the ground level. Percentage use of the above perches was calculated following the method of Bell and Ford (1990).

Perch height: The availability of various perch heights in the feeding sites of the birds was grouped as 0 to 3 m, 3 to 6m, 6 to 9m, 9 to 12 m and 12 to 15m and the per cent use was calculated.

Perching height: This refers to the height at which the birds perched while feeding. The perching heights were grouped as 0 to3m, 3to 6m, 6 to 9m, 9 to 12 m and 12 to 15m and their percentage use was calculated.

Foraging height: Foraging height of the birds was classified as 0to3m, 3 to 6m, 6 to 9m, 9 to 12m and 12 to 15 m and the percentage use at different foraging heights were classified

Foraging substrate: The foraging substrates of the birds were classified as (a) air (b) plants and (c) ground feeding, and in each case the percentage use was estimated.

Foraging plants: The birds were observed to feed on insects found on trees, shrubs and herbs. The percentage use of above plant categories was estimated.

Foraging position on trees: The use of various positions on trees for insect feeding was classified as canopy, trunk and base, and the percentage use of each category was calculated.

Foraging height on plants : The percentage of insect captures by the birds at different height categories of plants while feeding was grouped as 0 to 3m, 3 to 6m, 6 to 9m , 9to 12m and 12 to 15m and 15 to 18m.

Foraging method: The foraging strategies of the birds were classified into (a) hawking (b) gleaning, and (c) ground feeding

Niche breadth: Shannon-Weiner (1949) measure (H′) was used to calculate diversity measures. Niche breadth values were based on Levins (1968) measure of Niche breadth using the following formula:

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$$B = \frac{1}{\sum Pi^2}$$

Principal Component Analysis was used to study the niche/resource partitioning among three birds studied. This method was used to factorize a group of 10 behavioral features associated with the insectivory of the factors studied.

RESULTS

A total of 2067 observations on foraging behavior of the birds were recorded and compared.

Perch use: Details of perch types used, perch height and perching heights of the birds are presented in table 1. The perches used included electric wires/ telegraphic wires, walls, trees, shrubs and others which included mounds above the ground level. Of the various perches the use of electric wires/ telegraphic wires was relatively higher (48.59%) than other types in the Bee eaters and the Blue jay (47.28%), while the Drong used trees as perches more than other perch types. Walls were used 5.70 % times by the Bee eater 3. 06% by the Drongo and 0.70% by the Blue jay.

The height of perches varied from 0.1 to15 m and in general perches of 6 to 9m height seemed to have been preferred by all the bird species. Less than 3m high perches were used 8.3% by the Bee eater, 18.23% by the Drongo and 19.96% by the Blue jay. Similarly the perching height of the birds ranged between 0 and 15m and the most preferred perching height category was 6 to 9m for all the three birds.

Foraging height: Of the various foraging height categories insects were mostly caught at the height of 0 to 3 m above the ground level by all the three birds(Table 2).

Foraging substrate: All the three birds were predominantly aerial foragers as the percentage use of air was 81.19% for the Bee eater, 71.50% in the Drongo and 62.50% in the Blue jay (Table3).

Foraging plants: Among trees, shrubs and herbs, the use of herbs was highest for all three birds. In general its use was more than 57% (Table 4).

Foraging position on trees: Per cent use of canopy was 40.47% for the Bee eaters, 60.71% for the Drongo and the Blue jay used the base up to 58.65% for this purpose (Table 5).

Foraging height on plants: Of the various height categories of plants all the three birds used mostly below 3m, as its per cent use was 77. 17%, 83.43% and 74.25% for the Bee eater, Drongo and the Blue jay respectively (Table 6).

Table 1: Per cent use of different perch types, perch heights and perching height categories of the Bee-eater, Drongo and the Blue jay

	Variable	Bee-eater (n=2067)	Species	
			Drongo (n=584)	Blue jay (n=571)
1.	Perch type			
a.	Electric wires/ Telegraphic wires	48.59	37.41	47.28
b.	Walls	5.70	3.06	0.70
c.	Trees	30.58	38.55	31.87
d.	Shrubs	12.57	11.25	15.76
e.	Others	2.51	9.00	4.37
2.	Perch height			
	0-3 m	8.30	18.23	19.96
	3-6 m	15.31	10.08	8.40
	6-9 m	60.64	49.20	50.61
	9-12 m	14.44	22.47	21.01
	12-15 m	0.76	0.00	0.00
3.	Perching height			
	0-3 m	9.76	17.92	19.61
	3-6 m	24.97	16.87	11.90
	6-9 m	59.19	51.14	50.43
	9-12 m	5.75	14.05	18.03
	12-15 m	0.25	0.00	0.00

Table 2: Per cent insect captures at different height categories while feeding by the three bird species studied

	Foraging height (m)				
Species	0-3	3-6	6-9	9-12	12-15
Bee-eater (n=2067)	53.96	39.97	5.51	0.34	0.19
Drongo (n=584)	60.27	35.96	2.74	1.02	0.00
Blue jay (n=571)	69.17	28.37	0.30	1.22	0.87

Table 3: Percent insect captures from the three foraging substrate categories by the three bird species studied

	Substrate types (%)		
Species	Air	Plants	Ground
Bee-eater (n=2067)	81.19	11.94	6.85
Drongo (n=584)	71.50	16.25	12.23
Blue jay (n=571)	62.50	28.03	9.46

Table 4: Per cent insect captures at different plant categories by the three birds species studied

	Foraging plants		
Species	Trees	Shrubs	Herbs
Bee-eater (n=387)	18.08	24.54	57.36
Drongo (n=167)	17.96	18.56	63.47
Blue jay (n=246)	10.16	30.89	58.94

Table 5: Per cent capture of insects at different tree positions by the three bird species studied

	Foraging positions		
Species	Canopy	Trunk	Base
Bee-eater (n=84)	40.47	38.09	21.42
Drongo (n=28)	60.71	17.85	21.42
Blue jay (n=43)	29.26	12.19	58.65

Table 6: Per cent insect captures at different height categories of plants by the three bird species when the birds fed on insects at them.

	Height categories					
Species	0-3 m	3-6 m	6-9 m	9-12 m	12-15 m	15-18 m
Bee-eater (n=368)	77.17	10.59	5.97	4.61	1.63	0.00
Drongo (n=157)	83.43	5.73	4.45	6.36	0.00	0.00
Blue jay (n=202)	74.25	18.31	0.99	1.48	2.47	2.47

Table 7: Per cent use of different foraging methods for insect feeding by the bird species studied

	Foraging method		
Species/	Aerial	Cleaning	Ground feeding
Bee-eater (n=2067)	81.00	10.90	7.99
Drongo (n=584)	76.70	13.80	9.41
Blue jay (n=571)	72.30	17.80	9.80

Table 8: Niche breath values for the three bird species for various foraging behavioural features

Species	Perch types	perch height	perching height	Feeding substrate	Feeding height	Feeding plants	Feeding position on trees	Feeding height on plants	Feeding method	Feeding periods	Habitat types
	n=5	n=5	n=5	n=3	n=5	n=3	n=3	n=6	n=3	n=4	n=3
Bee-eater	2.86	2.38	2.35	1.47	2.65	2.37	2.81	1.6	1.48	3.81	2.90
	(0.465)	(0.345)	(0.337)	(0.235)	(0.412)	(0.685)	(0.905)	(0.126	(0.240)	(0.936)	(0.950)
Drongo	3.24	2.97	2.92	1.81	2.02	2.13	2.24	1.42	1.62	3.10	2.93
	(0.560)	(0.492)	(0.480)	(0.405)	(0.255)	(0.565)	(0.620)	(0.084)	(0.310)	(0.700)	(0.965)
	2.84	2.88	2.94	2.09	1.78	2.20	2.57	1.71	1.81	3.87	2.29
	(0.460)	(0.470)	(0.485)	(0.545)	(0.195)	(0.600)	(0.785)	(0.142)	(0.405)	(0.956)	(0.645)

Values in parentheses are standardized niche breadth values.

Table 9: Factor loading derived from the Principal Component Analysis of feeding behavioral features of the 3 insectivorous birds studied .Dominant loadings are underlined

	Factors		
Variable	I	II	III
Perch height	0.908	-0.166	-0.073
Perching height	0.899	-0.127	0.016
Perch type(Trees)	0.674	0.090	-0.175
Feeding substrate (Plants)	0.008	0.812	0.022
Feeding method(Aerial)	0.115	-0.713	0.038
Feeding height	0.136	0.013	-0.983
Total variance			
Explained (%)	35.03	20.32	16.74
Cumulative %	35.03	55.35	72.09

The niche breadth values of foraging birds showed that the Bee-eater and Blue jay were more or less similar in their perch use. The Drongo used greater variety of perches that the species (Table 8).

Principal Component Analysis

Principal Component Analysis reduced ten feeding behavioural variables to three Principal Components that accounted for 72.09% of total variation in the data set (Table 9). Component I accounted for 35.03% of the variation and was mostly influenced by perch height, perching height and perch types. Feeding substrate types (plants) and feeding method (aerial) mostly influenced the component II, which accounted for an additional 20.32% of the variation. Feeding height contributed most heavily to component III, which accounted for 16.74% of the total variation. Data on foraging behaviour of each insectivorous bird were projected onto three principal components by plotting the centroids of factor scores along the Principal component axis (Fig.1). The birds were separated into three positions that reflected their different ecological niche in their ecosystem. The Bee-eater was separated from other birds by the nature of perches used for foraging (Component I) by feeding substrate and feeding method (Component II) and also by feeding height (Component III). The analysis suggested that the Bee-eaters used lower perches than other two birds (Component I) while foraging. Further, they depended more on aerial feeding than the other two birds (Component II) and obtained food from comparatively greater heights than the other two birds (Component III) (Table 9 and Fig. 1).

DISCUSSION

Perch use

The small Green Bee-eater is essentially a "sit and wait" predator. Fry (1984) stated that, "the small Green Bee-eaters obtain their food by fly catching" choosing a perch overlooking open air space where they can give unimpeded chase to any suitable insect that happens to pass by, a technique which recently has been called 'sentinel feeding'. Captures are brought back to the perch never more than one insect at a time, to be immobilized and consumed there. It is a 'sit and wait' strategy, and the birds do not actively seek out insects. Only by moving from time to time to other lookout perches nearby can such Bee-eater be said to be actively involved in hunting their prey".

The small Green Bee-eater used a variety of structures as hunting perches, the most predominant among them being telegraph and electric wires, small walls, trees and shrubs. Perches are considered important to the habitat

of many bird species especially as an essential requirement of hunting their prey (Bent, 1938; Craighead and Craighead, 1956). Moreover perch hunting has been regarded as one that requires little energy expenditures, as well (Wakely, 1979). The importance of perches for hunting, resting and feeding as well as other activities has been well documented previously by several investigators (Forren, 1981; Reinert, 1984; Askham, 1990). The use of perches for hunting insect prey by Bee-eater species has been reported already by Fry (1969), Douthwaite and Fry (1982) and Fry (1984). Hunt by searching from elevated perches was described for the red throated Bee-eater *M. bullocki* by Fry (1969) and for the Little Bee-eater *M.pusillus* by Douthwaite and Fry (1982). Douthwaite and Fry (1982) stated that *M.pusillus* searched insect prey from "elevated perches and on seeing flying insects the bird flies rapidly towards it, seizes it in the tip of the beak and glide back in an arc to the same perch". Then the prey is immobilized by beating and in the case of a bee devenomed by wiping against the perch in *M.bullocki*. The observations of the present study were similar to their reports.

The Bee-eater used perches of varying heights, but in general they seemed to have preferred perches of height 6-9m and tended to hunt. Fry (1982) reported that commanding perches which barely interrupted views up to 200 to 300 m were favoured and stated further that the perch height seemed to be dependent upon the type of ground vegetation in the feeding grounds. A perching height of 6-9 m is the optimum height that fulfilled the above criteria in the study area and as such the preferred perch height of *M. orientalis* appears to be in accordance with the findings for *M. pusillus* by Douthwaite and Fry (1982). However, one must bear in mind that the nature and height of perches used might also be related to the type of prey captured and their seasonal variations as well, as reported in thornbills by Bell (1985 a,b)

Foraging height

The small Green Bee-eaters caught most of their insect prey (53.96%) at heights (foraging height) of about <3 m above ground level. This was in accordance with the statement of Douthwaite and Fry (1982) that *M. orientalis* and *M. pusillus* were the two species that fed mainly nearer to the ground levels than any of their congeners. However, studies by Blakers et al. (1984) and Brooker et al. (1990) on insectivorous birds showed that insectivorous birds in general were height generalists. The apparent disagreement to the above generalization with regard to M. *orientalis* in the present study might be due to selection of specific type of prey, feeding behaviour and the habitat types available in the study area hich are relatively open with dispersed vegetation.

FORAGING SUBSTRATE

The small Green Bee-eater was essentially an aerial feeder since 81.19 % of food captured were insects from air. This is in accordance with the general descriptions for Bee-eaters by Fry (1984) who stated that the Bee-eaters in general are flycatchers, *M. orientalis* nevertheless did not deviate from its congeners in this aspect. Ground feeding was found to be minimized for *M. orientalis* in the present study. Similar reports were given for *M. pusillus* by Douthwaite and Fry (1982) who stated that the little Bee-eaters never took prey from the ground. *M. orientalis* in the present study took only one insect per attempt and in this respect resembled *M. pusillus* (Douthwaite and Fry, 1982), but was in contrast to the layer species such as European, Blue cheeked and Carmine Bee-eater, *M. apiaster, M. persicus and M. nubicus* respectively, which feed aloft taking one insect after another in continuous flight without returning to the perch (Fry 1984).

Plant substrate

Whenever the small Green Bee-eater, *M. orientalis* fed on insects from plant substrates, they predominantly did so from herbs (57.39%) and avoided dense foliage either in the form of trees or shrubs. Fry (1982) explained this foraging behaviour of Bee-eaters by stating that true fly catchers and other small insectivores, like Bee-eaters, need space to manovare to catch fast flying hymenoptera and so they shun dense foliage.

Niche segregation/ Resource partitioning: The study indicates that all the three birds are aerial feeders and belong to the fly catching guild of insectivorous birds. This further indicated that the insect prey were almost the same Gause's (1934) principle, which was later refined as competitive exclusion (Hardin 1960), states that no two species can coexist in the same area indefinitely with identical food requirements. The above species thus must have some sort of resource partitioning among them in order to coexist in the same habitat. Principal Component Analysis indicates that Component I was perch characteristics (including perch types and heights and perching heights). Component II was feeding method (Feeding substrate and feeding method) and Component III was feeding height. Faaborg (1988) stated that ecological separation in diverse assemblage of birds is achieved through differences in body size, foraging time, foraging behaviour and shape, as is true in the present study.

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