

Research Article

**AVIAN DIVERSITY AND DEPENDENCY IN THE *CESTRUM*
AURENTIACUM BUSHES, NILGIRIS, INDIA**

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Article History: Received 16th March 2015; Accepted 28th May 2015; Published 15th June 2015

ABSTRACT

The study was conducted to assess the importance of the *Cestrum aurentiacum* in maintaining the avian diversity of the Nilgiris. The study was conducted from December to March in five different sample sites located at Ooty, the Nilgiris. The avian diversity was calculated by counting the number of birds in one hour. The experiment was repeated many times and the mean number/hr is calculated. The site selection was done as per the standard sampling ecological protocols. The composition of inflorescence, the column diameter of the flower, the nectar height also were studied and correlated to the avian diversity. The avian diversity was assessed by calculating the Shannon Index and Simpson's Index. Results shows that in the inflorescence there is a good number of mature flowers along with bud and the mature flowers contain plentiful quantity of nectar. Not only the birds, insects and other fauna were also attracted towards the *Cestrum* flowers. The *Cestrum* bushes are good nesting places and there are only minimum human disturbances. To be concluded, these reasons attract diverse faunal component to the *Cestrum* bushes. The study suggests that the exotic plant *Cestrum* bushes are becoming an unavoidable part of the Nilgiris supporting rich faunal diversity.

Keywords: *Cestrum*, Avian diversity, Avian dependency, Upper Nilgiris, Exotic plants.

INTRODUCTION

The Nilgiri Hills lies in between 11° 08' to 11° 37' N latitude and 76° 27' E to 77° 4' E longitude is the part of Nilgiri Biosphere Reserve (NBR) in the Western Ghats. Nilgiri hills have got a wide variety of flora and fauna with primitive evergreen sholas and deciduous forests. The fauna includes both the endemic and exotic species, which includes over 350 species of birds as its composition. The reserve has very rich plant diversity of 3300 species of plants in which 1232 species are endemic to the NBR. Apart from them, 2068 species of plants are exotic. Among the 2700 species of flowering plants, 160 species of fern and fern allies, countless types of flowerless plants, mosses, fungi, algae, land lichens are sighted in this district. No other hill station is said to have fostered as many as exotic species as are found in the Nilgiris. The exotic species are found in the Nilgiris are from the various part of the world and are considered to be trouble causers, by affecting the bio-diversity of the Nilgiris.

Cestrum is a genus of Solanaceae family with 150-250 species of flowering plants. They are native to warm temperate to tropical regions of the America, from the southern United States (Kunwar, 2003, Khan *et al.*, 2012). They are colloquially known as *Cestrum*'s or jasmynes (Bhattacharjee *et al.*, 2005). They are shrubs growing to 1-4 m tall. Most are evergreen a few are deciduous. Several species of *Cestrum* is grown as ornamental plants for their strongly scented flowers (Morton and Collectanea, 1976) and also reported to have medicinal properties (Sivaraj *et al.*, 2015). *Cestrum* species are used as food by the caterpillars of several Lepidoptera (Ehrlich *et al.*, 2013). These include the Glass wing and *Manduca afflicta* which possibly feeds only on day-blooming *Cestrum* (*C. diurnum*). *Cestrum aurentiacum* is a commonly seen exotic plant in the Nilgiris. There is a common sight, that the bushes of *Cestrum* bearing yellow flowers near even from urban to the village areas. Exotic species like *Cestrum* are considered as nuisance to the endemic fauna and flora, even

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this is considered to be poisonous. Under this consideration the current study was under taken to understand avian diversity and dependency in relation to nectar content, floral composition and floral structure. The study also aims to assess the reality that exotic species become unavoidable component in maintaining avian diversity inclusive of the endemic birds.

METHODOLOGY

Study was conducted in five sampling sites viz., Elk Hill (11°. 3881, 76°. 7289) Garden Mund (11°. 4191, 76°. 7113), Thettukkal (11°. 4046, 76°. 6862), Yellanahalli (11°. 3784, 76°. 7289) and Pykara (11°. 4547, 76°. 5979). Each of the study sites are divided into twelve quadrates and samples were collected according to the standard random sampling protocols described by Gotelli & Colwell (2001). *Cestrum aurantiacum*, also called as orange *Cestrum* or yellow *Cestrum* is a half climbing glabrous shrub with ovate leaves brought to the Nilgiris by the European settlers in 18th century. The flowering season is from February to July and fruiting period from August to December.

Floral studies were conducted at least in ten mature flowers from each bush. The diameter of the corolla tube, corolla length and nectary height were measured in all these flowers. The nectar volume is estimated by the formula " $\pi r^2 h$ ". Inflorescence composition was also studied by classifying flowers to categories such as Mature, Sub-mature, Young and Buds. Each category was quantified in each sample area and expressed in terms of arithmetic mean and Standard Error. One way ANOVA is carried out using PAST software.

The Bird count was carried out in the *Cestrum* vegetation through every hour at an interval of five consecutive hours. The bird density at a point of time was recorded and is repeated six times in an hour and the average is taken as the number of birds per hour at morning and evening where avian diversity is more. The experiment was repeated for three to five hours and the values were tabulated and expressed as mean value (rounded off to nearest number) and standard error of mean per hour for each bird. The Diversity is calculated by the Shannon-Weiner Index (Tramer, 1969) and Simpsons Index (Simpson, 1949).

RESULTS

Assorting the sites and the avian diversity at each of these areas were analyzed. The different types of birds observed in the *Cestrum* bushes in various sampling sites are given in table 1.

Though not all the birds are spotted at all these areas, the result summarizes various birds observed among the various areas chosen under study. The birds observed under the study includes: the Flycatchers, Sunbirds, Wagtail and Fantail, Common sparrows, Mynas, Warblers, Doves, White eyed Flower pecker, Tit and the Bulbul. The scientific names are also given in this table.

Table 1 represent the bird diversity at all the study sites in the *Cestrum* bushes expressed as the mean of number of birds per hour in the quadrate under consideration. The bird diversity at Rose Garden (Site 1) among the *Cestrum* bushes shows various birds like Ashy prinia, Common Myna, Greenish Leaf warbler, Grey Headed flycatcher, House sparrow, Oriental white-eyed, Pied Bushchat and the Red whiskered bulbul are the common visitors to this area. The avian diversity near Raj Bhavan (Site 2) points birds like Common sparrow, Oriental white-eyed, Common Myna, Red whiskered bulbul, Thick billed flower pecker, Pied Bushchat, Spotted dove, Grey headed flycatcher, White throated fantail flycatcher, Wagtail and Great tit as common visitors. Others are few when compared to the other birds mentioned here. At Garden Mund (Site 3) birds like House sparrow, Oriental white-eyed, Common Myna, Red whiskered bulbul, Thick billed flower pecker, Pied Bushchat, Spotted dove, Grey headed flycatcher and White throated fantail flycatcher, Wagtail and Great tit were observed. Among them, the density of House sparrow, Oriental white-eyed, Common Myna and Red whiskered bulbul are observed to be more in the in the Mund. Another feature observed in this area is the comparatively high number of major flycatchers like Grey headed flycatcher and White throated fantail flycatcher. The birds like House sparrow, Common Myna, Oriental white eyed, Red whiskered bulbul, Thick billed flower pecker, Pied Bushchat, Greenish Leaf warbler, Wag tail, Small sunbird, Black and Orange flycatcher, Grey headed flycatcher and Ashy prinia were observed commonly at Thettukkal (Site 4). As far as the density is concerned, it clearly depicts that House sparrow is the most

observed bird in this bushes. Oriental white eyed, bulbul and the flower pecker forms the other major shares. The avian diversity at Elk Hill (Site 5) shows that House sparrow, Oriental white eyed, Red whiskered bulbul, Pied Bushchat, Common Myna, White throated fantail flycatcher, Wag tail, Spotted dove, Thick billed flower pecker and the Great tit are present at this site. Data clearly presents that the birds like white eyed and house sparrows are present in relatively good quantity. Here the number of birds per hour is also comparatively high than the other areas.

Table 2 compares the two diversity indices regarding the avian diversity in *Cestrum* bushes. The Shannon index also called Shannon Weiner

index is relatively high in the study areas when compared to Simpson's index. However, it should be noted that Elk Hill and Thettukkal have less index value than the other areas. Similarly Simpson's diversity index also shows comparatively high value in all the study areas. It should be noted that the Simpson's index will always lies between 0-1. Here also it should be noted that the value is comparatively less at Elk Hill and Thettukkal.

Floral details of the *Cestrum aurentiacum* is given in table 3. The table depicts the details of floral column, diameter of the floral column and the nectary height. The ANOVA shows that the values significantly ($P>0.05$) differ from bush to bush.

Table 1. List of birds observed in *Cestrum* vegetation under study.

Sl.No.	Bird Name	No of Birds (Mean \pm SE)/hr				
		SITE 1	SITE2	SITE3	SITE4	SITE 5
1.	Ashy prinia	3.00 \pm 0.00	0	1 \pm 0.50	1 \pm 0.25	0
2.	Common Myna	2.00 \pm 0.00	4 \pm 0.87	1.00 \pm 0.71	5.00 \pm 2.27	3 \pm 1.00
3.	Greenish Leaf warbler	4.00 \pm 2.00	0	3 \pm 1.11	1 \pm 0.25	0
4.	Grey Headed flycatcher	2.00 \pm 1.00	2.00 \pm 0.71	3.00 \pm 0.87	1.00 \pm 0.75	0
5.	House sparrow	5.00 \pm 2.00	0	0	15.0 \pm 4.87	0
6.	Oriental white-eyed	8.00 \pm 2.00	8.00 \pm 1.11	8.00 \pm 0.48	4.25 \pm 1.31	14.0 \pm 9.37
7.	Pied Bushchat	3.00 \pm 1.00	4.00 \pm 1.55	2.00 \pm 0.48	1.75 \pm 0.48	2.00 \pm 0.46
8.	Red whiskered bulbul	6.00 \pm 2.00	5.00 \pm 0.75	3.00 \pm 1.18	3.00 \pm 0.25	2.00 \pm 0.72
9.	Common sparrow	0	10.0 \pm 4.86	18.0 \pm 4.13	0	18 \pm 3.19
10.	Thick billed flowerpecker	0	2.00 \pm 0.65	0.25 \pm 0.25	3.00 \pm 0.75	0.60 \pm 0.36
11.	Spotted dove	0	1.00 \pm 0.29	1.50 \pm 0.65	0	0.20 \pm 0.18
12.	White throated fantail flycatcher	0	1.00 \pm 0.75	0.50 \pm 0.50	0	1.80 \pm 0.72
13.	Wagtail	0	1.00 \pm 0.25	0	0.25 \pm 0.25	1.60 \pm 0.46
14.	Great tit	0	1.00 \pm 0.25	1.00 \pm 1.00	0	0.20 \pm 0.18
15.	Small sunbird	0	0	1.00 \pm 0.25	0.50 \pm 0.50	0
16.	Blue notch	0	0	1.00 \pm 0.25	0	0
17.	Nilgiri flycatcher	0	0	1.00 \pm 0.29	0	0
18.	Black & Orange flycatcher	0	0	1.00 \pm 0.29	1.00 \pm 0.75	0

Table 2. Comparison of diversity indices of birds among the study areas.

S.No.	Diversity index	Site 1	Site 2	Site3	Site 4	Site5
1.	Shannon-Weiner (H)	1.97	1.95	2.71	1.78	1.52
2.	Simpson's(D)	0.84	0.82	0.92	0.75	0.6

Table 3. Floral details of various *Cestrum aurentiacum* bushes.

Bush No.	Mean Floral Column diameter (Mean ± SE) (mm)	Mean Flower Column height (Mean ± SE) (cm)	Mean Nectary height (Mean ± SE) (cm)
1	1.32± 0.20	1.95± 0.16	0.280± 0.063
2	1.32± 0.26	1.96± 0.12	0.433± 0.087
3	1.28± 0.21	1.93± 0.12	0.270± 0.067
4	1.35± 0.14	1.77± 0.26	0.283± 0.098
5	1.33± 0.13	1.92± 0.09	0.320± 0.079
6	1.27± 0.12	1.84± 0.13	0.290± 0.099
7	1.12± 0.12	1.82± 0.12	0.257± 0.053
8	1.13± 0.12	1.85± 0.13	0.290± 0.074
9	1.16± 0.07	2.01± 0.14	0.267± 0.071
10	1.11± 0.09	1.76± 0.15	0.250± 0.053
ANOVA (F)	P>0.05	P>0.05	P>0.05

Figure 1 clearly proves that the nectar height and corolla tube height differ in different flowers but falls within a near similar range except for the second bush. The figure shows that the nectar percentage is altering around a value of the 15 % except in the second bush,

where it ranges to 25%. The estimated nectar volume is diagrammatically represented in this figure. The values here are calculated in cm³. The picture clearly explains that almost all bushes have constant volume of nectar in it.

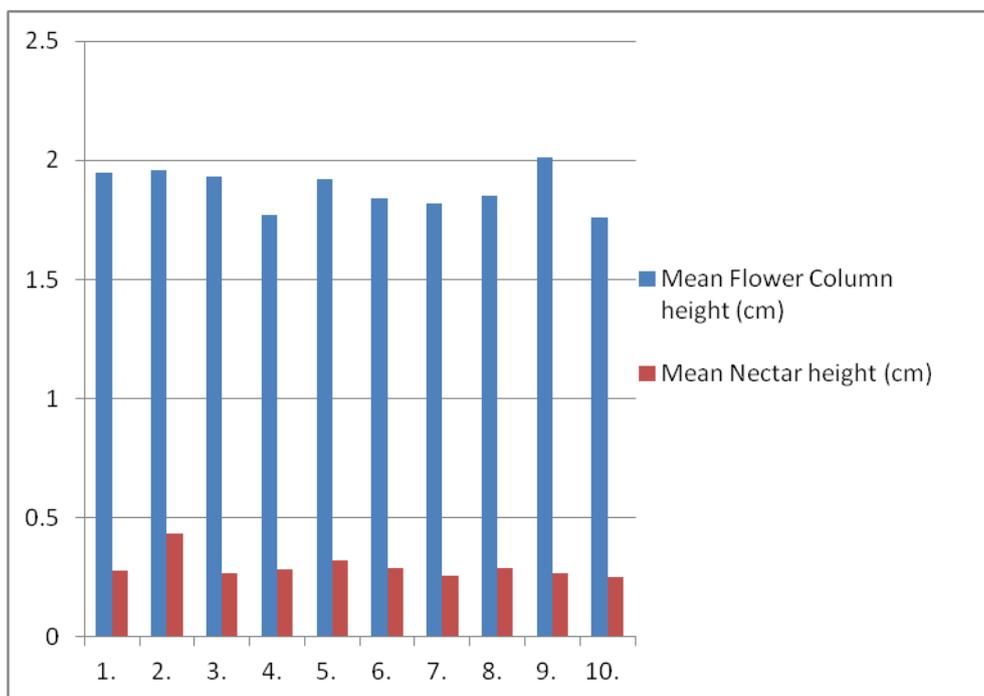


Figure 1. Comparison of the Nectary and Floral column Height among different flowers in various bushes.

Table 4 shows the floral composition in the inflorescence of the *Cestrum*. In all areas the inflorescence contain mature flower in good proportion and in second bush even though there are a lot of mature flowers, the inflorescence contain more buds also. The ANOVA analysis shows the floral composition of the inflorescence vary from the area to area and bush to bush.

Figure 2 shows the comparison of mean of various types of flowers in various four bushes. The data analysis shows bush four have maximum mature flowers, followed by bush 2 and one and bush three have the least. It is also clear that in bush 1, 2 and 4 the young flowers and buds are in a constant proportion.

Table 4. Floral composition in inflorescence of *Cestrum aurentiacum*.

Bush No	Type of flowers (Mean± SD) (No)			
	Mature	Sub Mature	Young	Bud
1	18.7 ± 8.29	10.0 ± 4.24	3.80 ± 3.56	4.17 ± 2.04 ^a
2	19.8 ± 10.8	14.7 ± 10.8	8.57 ± 5.97	17.00 ± 11.6 ^b
3	14.9 ± 5.65	15.3 ± 10.9	3.80 ± 2.17	3.13 ± 2.53 ^a
4	25.1 ± 12.9	9.60 ± 3.29	4.40 ± 1.14	4.80 ± 1.30 ^a
ANOVA (F)	NS	NS	NS	P>0.05

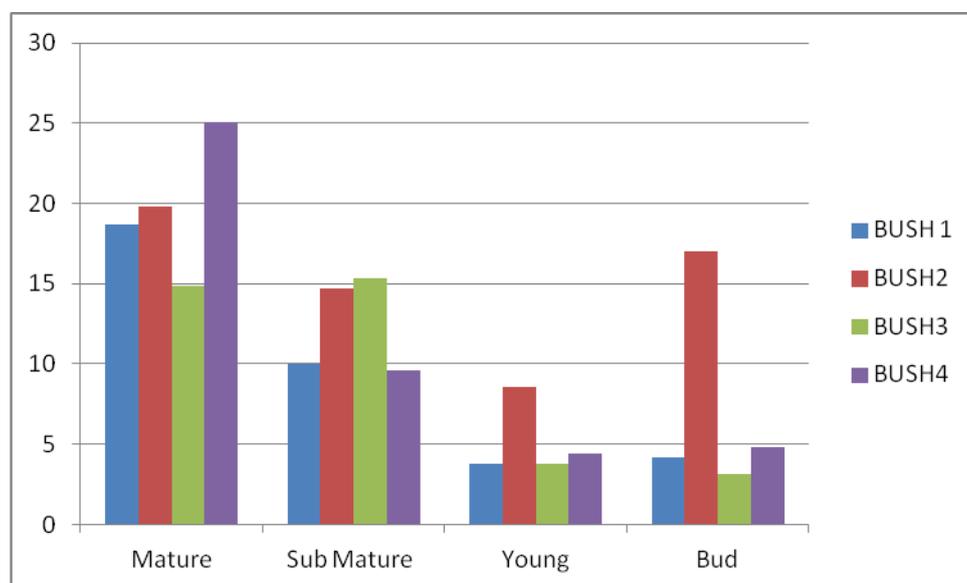


Figure 2. Comparison of floral composition among four bushes.

DISCUSSION

The term exotic plant is often used to describe plant species that have been, or were being, introduced in to the parts of the world other than their historical or documented range by humans, often as ornamental plants. While no plant species had ever been documented driving another species to extinction, exotics that escape from gardens were often labeled invasive species thought to outcompete native flora. In reality, however, this phenomenon is exclusively a result of other anthropogenic activities such as fertilizer runoff or habitat disruption/destruction. Only

human and a handful of domesticated mammalian species (particularly cats and pigs) had always been directly responsible for the extinction of another species. Currently it is of the concept that all those except the domesticated varieties should be considered as nuisance and must be removed from the environment at urgent pace.

Plantation in the Nilgiris was started in the 19th Century by clear felling of natural forests and burning of grasslands. Plantations constitute mainly black wattle, blue gum, Mexican pine, alder, cinchona, coffee, and tea. About five

species of *Acacia*, ten of *Eucalyptus* and four of pines were introduced for feeding the timber and pulp wood industry in the plains. By 1987, *Eucalyptus* alone covered about 12,000 ha (Meher-Homji 1989). Mexican pine has typically been planted in frost pockets, where wattle and blue gum had failed. Wattle, one of the most successful and extensively planted species, also regenerates through seed, forming impenetrable thickets of thin poles, blocking the passage of larger mammals. Today, plantations form the dominant cover across the length and breadth of the Nilgiris.

The case of *Cestrum* is not much different from what was mentioned above, this is also escaped from the gardens of the European people and now established its presence all through the Nilgiris. As a non-edible plant it survived safely and become an unavoidable part of the Nilgiris today. The results clearly show that the avian diversity index is comparatively high in the *Cestrum* bushes and this forms some sort of resort for resident birds of the Nilgiri Hills. Endemic birds like Nilgiri flycatcher and Oriental white eyed are present in good percentage and are of the proof that the birds start utilizing this Niche also. The studies on the nectar content shows it flower is offering a good percentage of nectar and this can be source of food (Nicolson and Fleming 2003; Johnson and Nicolson 2008) for many nectar drinking birds and insects. The attraction of the nectar and the orange coloration may attract the insects and there by many flycatchers. The main birds that visit the *Cestrum* are flycatchers, sunbirds, wagtail and fantail, common sparrows, mynas, warblers, doves, white eyed, flower pecker, tit and the bulbul. Sun birds and oriental white may take the nectar by using the pointed beak.

The Upper Nilgiris supports an interesting bird community, with nine Western Ghats endemic and several threatened species. In general, the bird composition of the upper Nilgiris appears to be lesser compared to the lower elevations. For instance, Gokula (1998) recorded 265 species in the Mudumalai Wildlife Sanctuary in the lower elevations of the Nilgiri hills, while 192 species is recorded in the Upper Nilgiris (Zarri and Rahmani 2005). This includes breeding residents, winter visitors, local summer migrants, vagrants and passage migrants. Of them, sixteen species are endemic to Western Ghats; many were recorded in our study (Table 1).

Spotted dove is a common, well spread in the Nilgiris (Jameson 1969), more often near habitations. Red whiskered bulbul (*Pycnonotus jocosus*) is a common resident, most conspicuous and noisy bulbul in the Nilgiris at all elevations. It nests from February to June and again in September after the southwest monsoon. Tame and confiding to a degree, in gardens and cultivated country, but equally common in open scrubby jungle, though it avoids heavy forest and the bare, treeless, grass downs of the plateau. Betts (1931) mentioned its 'fly catching' during the evening. The pied bush chat (*Saxicola caprata*), is a common breeding resident. Nest is usually well sheltered and placed in earthen banks close to the ground, lined with feathers, roots, down or other soft material. Has usually a clutch of four greenish-white eggs, speckled with brown. *Prinia socialis* is also a common resident, affects scrub, cultivation and degraded forests near roads or close to habitations. The oriental white eyed, *Zosterops palpebrosus* is also a common resident in the Upper Nilgiris but diminishes around the slopes. Often forms small mixed hunting parties, seldom quiet, gives away its presence by frequently uttered "chee chee". Nests are found between March and May, usually is a small cup comprising soft moss, lichens and spider webs, generally in shola undergrowth.

CONCLUSION

The current context demonstrates the avian friendly nature of *Cestrum* flowers due to its good inflorescence and mature flowers composition carried out from the assessments. It gains significance in having mutual benefits from birds as well as insects for pollination and providing good quantity of nectar in return. Apart from this, being a good shelter to birds for nesting and non-edible in nature it receives fewer disturbances. As an exotic species, *Cestrum* becomes an unavoidable part attracting good number of birds and supporting a healthy avian diversity in Nilgiris.

ACKNOWLEDGEMENTS

Authors acknowledge Ms. Punitha, C. for her help in the field while collecting the data, Nazia, A. for designing the work and Dr. J. Ebanasar, Head of the Department of Zoology, GAC, Ooty for providing the facilities.

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