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Diversity and nesting ecology of dwarf bee *Apis florea* (Fabr.) in the selected regions of Tamil Nadu, India.

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Abstract

Biodiversity and nesting ecology of dwarf bee *Apis florea* was carried out in different areas of Tamil Nadu, India. Totally154 colonies were observed, and among them 110 were live and 44 were abandoned colonies, and 23 of them were from human habitation and 131 colonies from non- human habitation located in areas covering 44 villages. 21 plant species were observed for nest-site selection by dwarf bee *A. florea* and were classified into two categories such as trees and shrubs. They included 12 tree and 9 species of shrub. Maximum of 17 colonies were observed in *Bambusa arudinaceae* followed by 12 and 11 were found in *Tectona grandis* and *Cocos nucifera* respectively. The length of nest varied from 10cms to 30cms and 64 nests were about 25 to 30cms. The preference of nest site selection by the *A. florea* was the height of 4 to 6 mts from the ground level, invariably near to a water source. The direction of colonies in the nest sites were in accordance with the prevailing wind direction. Thus, the aspect of nesting ecology of *Apis florea* mostly remained unchanged from its open nesting behavior.

Keywords: *Apis florea*, *Bambusa arudinaceae* Biodiversity,, *Cocos nucifera* Nesting Ecology, Tamil Nadu, *Tectona grandis*

INTRODUCTION

Honeybees are the most important pollinating insects for commercial fruit production. They are the only managed insects available for facilitating the pollination of variety of wild as well as cultivated plants throughout the world (Mayer, 1983). They play an important role in the conservation of forest and grass land ecosystem as they render essential ecological services such as cross pollination and propagation of plant species, thus they maintain the biological diversity (Verma, 1992), and also they prevent the extinction of minority plant species by their behavior of 'floral fidelity' (Wells and Wells, 1985 ; Camazine et al., 1999).The species of honey bees, bumble-bees and sting less-bees built the nest in cavities; predominantly tree hollows, and also in abandoned rodent burrows, cavities in old terminate nests and under the leaf litter. These cavities are well insulated, which help the colonies to retain metabolic heat and providing protection from variations in ambient temperature (Heinrich, 1979, 1981).

New nest site selection is one of the most important decisions that an insect colony has to make for its reproductive success (Franks and Dornhaus, 2003; Franks *et al*., 2002). The nesting site of different honeybees varies from species to species like *A. cerana* and *A. mellifera* which build closed nests,well protected from sun, wind, and rain, the tree holes, cavities among buildings and empty cans which provide suitable nesting site, whereas *A.dorsata* and *A. florea* belong to open nest builders, where the nests are exposed to sun, wind and rain. However, the open-nesting honey bees, which occur in tropical environments, build a nest in the open, choosing sites with appropriate levels of solar radiation. As the open nesting honey bee species from the basal clades of the honey bee tribe (Engel and Schultz, 1997; Arias and Sheppard, 2005), the colonization of temperature areas may have been facilitated by the move into protective cavities (Ruttner, 1988; Oldroyd and Wongsiri, 2006).

The occupation of a favourbale nest site is important for nesting insects like honey bees since it can affect their survival reproduction and disease occurrence (Seeley, 1985). Previous studies on the nesting were carried out in Central and North India (Deodilar *et al.*, 1977; Mishra and Yazdani, 1977). Various aspects of the nesting behaviours and rates of colonization and decolonization of honey bees have been reported (Reddy, 1983; Reddy and Reddy,1986). The biodiversity and nesting ecology of *A. florea* in the different areas of Tamil Nadu was under taken to understand the factors influencing the nest-site selection of the dwarf bee *A. florea* and structure and characteristics of the nests

Study area: The present study was carried out in different locations in Tamil Nadu (10.78605°N 78.47995°E), India covering plains, hills and coastal areas.

Location of the *Apis florea* nests: Visual search by traveling through the study area by road and enquiring people especially children in the villages

Colony diversity: Visuall counting of the number of live nest and abandoned nests.

Nest-site Description: Nature of the nest site- tree species and human habitation. Nest height from the ground- 5,10,15,20,25,30,35 and >50 mtrs. Nest

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exposure to sunlight – Partial, Full and No exposure. Distance of water source from the nest- site.

Nest structure: Length and width of the nest. Exposure to sunlight and comb direction – EW, NS, NE, SW (Field compass) and length and width of the nests were measured by divider.

RESULTS AND DICUSSION

A total of 154 nests were found in 44 villages throughout the study area during the study period from March 2012 to March 2014. A few images of the nest – sites of *A.florea* are shown in Figure 1. Among these nests, 110 were live and 44 were abandoned (Table 1-3). All those nests were built in 21 plant species, among them *Bambusa arudinanceae* (Bamboo) had high number of nests (17) followed by *Tectona grandis* and *Cocos nucifera* had 12 and 11 respectively .Most of the plants selected by *A. florea* as nest sites are both trees and shrubs. The 55 nests of *A. florea* were found in trees consisting 13 species and 99 colonies in 9 species of shrubs. It was recorded that the dwarf bee *A.florea* selected the nest site at a height minimum of 2 mts and maximum of at 18mts and the average nest height was at 7.43 mts and 32.8% of nesting sites were at 4-6 mts from the ground level.

Direction and orientation of nesting by *A.slorea* were more (41) towards South-Western direction (41 nests) and 18 nests were North-Western direction. It was found that 29 nests were completely exposed to sunlight and 128 nests were partially exposed to sunlight and 7 nests were not exposed to sunlight. Hence 46.2% of nest site selection was in partial exposure to sunlight and 43.2% of the sites were completely exposed to sunlight and 10.4% of the nest site selection was in areas without sunlight.

A total of 40 nests were observed in 1 to 2 meters radius of water source and just 4 nests were located from 3 to 4 mts radius of water source. It was noticed that 6 nests were located between 4 and 5 mts radius and the colonies of *A. florea* were frequently disturbed by human intervention. It was also found that about 23 nests were nearer to human habitation and 131 were away from human habitation. The morphometrics of the nests was also measured, 126 nests were between 10 and 15cms. 28 nests were between 20 and 27 cms in length. The width of 113 nests was between 5 and 15 cm and 41 nests were measured between 25 and 30 cm.

The present study clearly indicates that *A. florea* has open nesting behaviour when compared with *A. cerana and A. mellifera*. During this study there were 22 plant species found as the host plant for nesting. Most of the nests were nearer to human habitation. It was found that the selection of nest site by the dwarf bee *A. florae* was mostly close to water source. Water is an important factor for temperature regulation and food process inside the colony as reported by Seeley and Morse (1976) and Seeley (1994,1995). A comparison was made with *Apis dorsata* which selected the nest site on tall trees with many branches and most preferably on high rocks (Verma, 1992 ; Underwood, 1990), whereas *Apis florea* selected the site for nesting at low height and short branched trees which were not located on rocky substratum.

Nest site selection plays -a major role in the ability of social insect colonies to maintain stable nest temperatures. Nest site choice falls in to two broad categories. For many species, the main criterion when selecting a nest site is physical protection against environmental perturbations; others select sites where the microclimate provides a relatively stable temperature. One of the behavior responses of most, if not all, social bee species to low temperatures is clustering. Workers are able to maintain stable brood nest temperatures at low ambient temperatures by forming fifth clusters on or around the brood area and generating metabolic heat. Workers adjust the cluster shape and density by moving closer together or further apart, allowing them to fine-tune their response to temperature change (Seeley and Morse, 1976; Seeley and Buhrman, 2001).

Oldroyd *et al.* (2008) suggested that the method of nest site selection is based on the efforts of a few bees is pleisiomorpic for the genus. *A.flore*a is phylogenetically basal to the genus, whereas the cavity-nesting species like *A.mellifera* is the most derived (Oldroyd and Wongsiri, 2006; Raffiudin and Croxier, 2007). Since both species select the direction and the swarm travels via dancing, it is concluded that this method of nest site selection had already evolved in the common ancestor of modern *Apis.* The interim cluster formed by the cavity nesting bees while they select a permanent home (Winston, 1987) may have its antecedents in the temporary nests of the king seen in the migratory open nesting species such as *A.dorsata* (Dyer and Seeley, 1994; Itioka *et al*., 2001; Paar *et al*., 2004), *Apis laboriosa* (Underwood 1990,1992) and *A.florea* (Pandey, 1974; Sheikh and Chetry, 2000; Oldroyd *et al.,* 2008).

A recent study (Seeley, 2003; Oldroyd *et al*., 2008)) has addressed the critical issue of weather scouts that abandon a site do so only after they have followed dances for and made visit to a superior site or wear they will abandon site even before they have experienced these external stimuli. The behaviour of the first few (4-8) bees clearly indicates that the study area is potentially suitable for beekeeping. All the colonies were observed on 22 plant species, which indicates the availability of enough bee florae in the study area. Studies on the diversity of flora, pollen and nectarise in relation to dwarf bee *A.flore* are the need

Table1. Nests of dwarf bee *Apis florea* with regards to area during the study period

S.No.	Location of nests	No of the live nests	No of the abundant nests	Total nests
1	Serunellur	4	1	5
2	Palayanur	2	0	2
3	Mannampandal (AVC College)	3	1	4
4	Sirkazhi	2	0	2
5	Coimbature (Bharathiar Univesity)	2	0	2
6	Sellur	1	0	1
7	Kakalani	2	1	3
8	Elupur	2	0	2
9	Authur	3	2	5
10	Thevur	2	0	2
11	Semangalam	1	0	1
12	Neelapadi	3	1	4
13	Kolli-hills	4	2	6
14	Sangamangalam	1	0	1
15	Sathiyamangalam	11	0	11
16	Paramakudi	2	5	7
17	Karapidakai	3	0	3
18	Thirupoondi	1	0	1
19	Panjanathikulam	1	0	1
20	Vellore	4	2	6
21	kodikanal	1	0	1
22	Chidambaram	1	0	1
23	North Poigainallur	1	0	1
24	Ooty	8	3	11
25	Velankanni	1	0	1
26	Karaikal	4	5	10
27	Kurumanakudi	1	0	1
28	Pichavaram -Mangroves	7	1	8
29	Ramarmadam	1	0	1
30	Theni	6	1	6
31	Rathamangalam	1	0	1
32	Vadakalathur	1	0	1
33	Kuthalam	2	0	2
34	Karaikudi	0	2	2
35	Puthamangalm	0	1	1
36	Erathaimathakadi	3	0	3
37	Kumbakonam	0	1	1
38	Valamangalam	1	0	1
39	Muthupet	5	0	5
40	KaruvalenKadai	0	1	1
41	Madurai-melur	2	1	3
42	Marthandam	4	1	5
43	Thirunelveli	7	5	12
44	Ranipet	3	3	6
	Total	**114**	**40**	**154**

Table 2. Nests abundance of dwarf bee *Apis florea* in relation to plants species during the study period.

S.No.	Plant species	No. of colonies
1	*Azadirachta indica*	09
2	*Annona squamosa*	06
3	*Bambusa arudinanceae*	17
4	*Borasus fiabellifer*	10
5	*Cocos nucifera*	11
6	*Citrus lemon*	06
7	*Ficus religiosa*	06
8	*Ficus sp.*	05
9	*Groten sp.*	08
10	*Hibiscus rosasinensis*	07
11	*Jatropha curcas*	08
12	*Mangifera indica*	06
13	*Musa paradisica*	04
14	*Murraya koringii*	06
15	*Nerium odorum*	05
16	*Prosopsis julifera*	08
17	*Phoenix.sp*	02
18	*Mangrove sps*	08
19	*Tamerindus indica*	06
20	*Tectona grandis*	12
21	*Thespesia populenea*	04
	Total	**154**

of the hour. In many species, the colony makes considerable investment in the nest site, furnishing it with combs and lining the interior with protective barriers (Seeley and Morse, 1976; Seely et al., 1979; Hepburn, 1986; Roubik, 2006), and it is also costly to abandon a site., Therefore, many social insect species have evolved elaborate mechanisms to search for new nest sites, evaluate their relative merits and to decide on the best site possible (Seeley and Visscher, 2003, 2004 ; Seeley et al., 2003, 2006; Visscher, 2007).

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Figure 1. A few nests o *Apis florea* in different plants found during the study period

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Table 3. Topography of the nest - site selection by the dwarf bee *Apis florea* during the study period.

Sl.No.	Factors	Categories	No. of Nests
1.	Nature	No. of live colony	110
		No of abundant colony	44
2.	Habitat	Human habitation	23
		Others	131
3.	Nest Length	05-10 cm	00
		10-15 cm	03
		15-20 cm	32
		20-25 cm	45
		25-30 cm	64
4	Nest width	05-10 cm	17
		10-15 cm	24
		15-20 cm	43
		20-25 cm	32
		25-30 cm	38
5	Nest direction	East-Western	19
		North-Southern	22
		North-Weastern	18
		North-Eastern	21
		South-Eastern	33
		South-Weatern	41

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