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Nest Architecture and Nesting Behaviour of the Large Carpenter Bee in Tamil Nadu, India

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Abstract

Large carpenter bee, *Xylocopa* sp., construct their nests in the dead woods, pruned branches and sticks, which were hollow with the presence of chewed saw dusts and pollen grains at the nest entrance. Nests were found naturally on Jamun *S. cumini* and *Azadirachta indica* L trees. The nests were simple, linear with brood cells partitioned with chewed straw materials. The nest architecture of large carpenter bee, *Xylocopa* sp., the nest entrance was oval in shape with 1.25 ± 0.25 cm diameter, the length and width of the nest was 23.37 ± 9.67 cm and 1.5 ± 0.24 cm; length of the brood cell was 2.44 ± 0.66 cm, which was partitioned with the thickness of 0.48 ± 0.29 cm.

Keywords: *Xylocopa* sp., nesting behaviour, nest architecture, floral colour

Introduction

Large carpenter bees belong to the family Apidae, tribe Xylocopini, and genus *Xylocopa* and they play a vital role in pollination of both cultivated and wild flora. Female bees gather pollen and nectar to provision their young ones. They exhibit specialized nesting behavior, constructing nests in wooden structures, hollow stems, and pithy stems of *Calotropis procera* (Hannan *et al.*, 2012) [3], as well as bamboo culms (Hongjamrassilp and Warrit, 2014) [7]. However, members of the subgenus *Proxylocopa* and *Xylocopa xinjiangensis* build their nests in soil (He and Zhu, 2018) [6]. *Xylocopa ordinaria* Smith relies on the availability of suitable wood for nesting substrates rather than taxonomic affinity (Bernardino and Ganglianone, 2008) [2].

Females construct linear nests with the help of powerful mandibles, creating a series of brood cells ranging from 14 to 20 mm in length. Each brood chamber is separated by partitions approximately 2 mm thick (Vicidomini, 1996) [14]. They collect pollen and nectar to form a pollen mass, which is provisioned inside the brood cell, where an egg is then laid (Prashantha and Belavadi, 2017) [10]. After oviposition, the brood cell is closed with sawdust. The brooding pattern includes two to four generations per annum, and the same nest is reused in the next season. Females remain at the nest entrance until brood emergence (Zafar and Raju, 2014) [15].

Carpenter bee nests are attacked by several types of natural enemies, including parasitoid wasps and flies, predatory wasps, blister beetles, ants, termites, and insectivorous birds (Tamar, 2010) [13]. Phoretic mites are housed in grooves or cavities, which are known as acarinariums. For instance, a number of bees and wasps have acarinarium on their mesosoma and metasoma (Okabe and Makino, 2002) [9]. In large carpenter bees of the *Xylocopa* species, one metasomal acarinarium on the first tergite of variable sizes and forms, and two comparatively small cavities on the mesosoma. Mutualisms may exist between carpenter bees with acarinarium and their associated mites, but most interactions are considered cleptoparasitism, with mites feeding on the host pollen loaf and faeces (Okabe *et al.*, 2008) [8].

Materials and Methods

Sample location: Nest samples were collected from college premises of Agricultural College and Research Institute, Madurai, Tamil Nadu Agricultural University, Nest of *Xylocopa* (K.) *pubescens* S. was located at Agricultural Research Station, Vellore (TNAU), and KVK Namakkal premises.

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Nest Identification: The natural nests constructed by large carpenter bee, *Xylocopa* spp were located by the frequent visits made by the female bee round the nest entrance with a typical buzzing sound and presence of chewed up saw dust and pollen droppings at the nest entrance. The nests were found on the dried branches of trees like neem, *Azadirachta indica* L. and Jamun, *Syzygium cumini* L. with numerous entrance holes.

Nest Data Collection

The nests were brought to the laboratory and recorded the inner contents. Nest entrance was closed with the help of cello tape to allow the adult bees inside for further study. Knife was used to open the nest and recorded the inner content viz., size and shape of the nest entrance, length and width of the nest, number of brood cells per nest, thickness of partitions, number of adult bees per nest and direction of nest entrance. If any immature's present inside the nest was also recorded. The parasites associated with the large carpenter bees were collected and documented. The collected specimens were preserved in 70% ethanol and were later examined using a dissecting microscope. A few nests were collected from *Syzygium cumini*, *Azadirachta indica* and natural bamboo. The nest portion between bamboo joints was removed in the field, and 2 days later in the laboratory, the nest was opened by cutting it in half lengthwise. The diameter of each nested shoot was recorded. The investigation was carried out to document the foraging activity of large carpenter bees on flowering crops of cultivated and weed flora.

Results

All the observed nests were linear in shape with the circular nest entrance diameter of 1.25 ± 0.25 cm. The total length and width of the nest were 23.37 ± 9.67 cm and 1.5 ± 0.24 cm, respectively. Numerous brood cells were observed but without immature stages. Each brood cell was partitioned using the chewed-up fibrous material. The thickness of the partition was recorded to be 0.48 ± 0.29 cm with an average range of 0.3 to 1 cm, respectively. The number of adults during nest collection was 2.5 ± 0.5 , respectively. The *Xylocopa* spp nest was linear, simple, unbranched with single nest entrance (Table 1).

Nest length was recorded as an average of 23.37 ± 9.61 cm, the brood cells were recorded an average numbers as 5 numbers, whereas similar observations were recorded by Hongjamrassilp and Warrit, (2014)^[7] in *X. (Biluna) nasalis* was 25.40 ± 6.95 cm, brood cells was ranged 0-8 (Table 1).

Xylocopa (Biluna) nasalis, *X. fenestrata*, *X. (K.) pubescens*, *X. (P.) latipes*, *Xylocopa* sp., prefer to forage on plants to collect pollen as well as nectar from both cultivated and uncultivated crops. Most preferred colour in descending order yellow > purple > white > pink (Table 2).

In present investigation parasites associated with the solitary bees were collected and documented. As many as 45 first instars of *Cissites* sp. belonging to Meloidae family, Order: Coleoptera. Instars were golden brown in colour and clinging to the hairs of the both male and female large carpenter bee, *X. (Platynopoda) latipes* during roosting on the weed (Fig. 4)

Phoretic mites belonging to the family *Macrocheles* sp. belonging to family Macrochelidae order Acarina were collected from female large carpenter bee *X. (Koptortosoma) pubescence*. Mites were whitish brown in colour and placed in acarinarium,

which is placed at the thoracic region (Fig. 5)

Discussion

The nest of *Xylocopa* (K.) *pubescens* S. direction of nest entrance was horizontal towards the ground position, nest entrance was directed towards west. The present findings fall in line with the findings of Zafar and Raju (2014)^[15] they also observed *X. latipes* and *X. pubescence* nests in the dead wood branches of *S. cumini*, *C. siamea* and Bamboo culms. Whereas, Batra (1984)^[1], observed the similar nesting behaviour of *X. latipes* and *X. pubescence* in dead woods. However, *Xylocopa* sp., utilized the availability of plant sources in the surrounding habitats, *X. sulcatipes* preferred *C. procera* as the nesting site (Hannan *et al.*, 2012)^[3].

The *Xylocopa* sp., nest was linear, simple, unbranched with single nest entrance. The present findings were accordance with the findings of Prashantha and Belvadi (2017)^[10], who reported the nesting behaviour of *X. nasalis* preferred the pithy stems nest architecture was simple and unbranched. However, few other species of *Xylocopa*, was reported to construct their nest both branching and unbranching type in dead woods (Rahman and Deka, 2011)^[11].

In present investigation, *Xylocopa* sp. nests not observed in other materials other than woody substrates. But, He and Zhu, (2018)^[6] they reported *X. xinjiangensis* constructed their nests in soil walls of mounds, gullies. Adult females of *Xylocopa* sp. was observed to excavate the inner content of the dried branches using strong mandibles, brood cell partition was made with the chewed straw. Hongjamrassilp and Warrit (2014)^[7] reported similar findings in the nest architecture of *X. (Biluna) nasalis* in the Bamboo culms, constructed their nest linearly. Additionally, they recorded the nesting biology of the *X. nasalis*. Moreover, the results are in accordance with the publications of Prashantha and Belavadi (2017)^[10] who recorded that *X. nasalis* mass brood cells were separated with the partitions, which were made by the excavated pithy straw.

Nest length was recorded as an average of 23.37 ± 9.61 cm, the brood cells were recorded an average numbers as 5 numbers, whereas similar observations were recorded by Hongjamrassilp and Warrit, (2014)^[7] in *X. (Biluna) nasalis* was 25.40 ± 6.95 cm, brood cells was ranged 0-8.

Xylocopa sp. was abundant in Fabaceae and Pedaliaceae, Verbenaceae and Asteraceae, and the least preference was shown towards Bignoniaceae. Present investigation showed that large carpenter bee attracted more to yellow colour. Raju and Rao (2006) reported that large carpenter bees, *X. latipes* and *X. pubescens* mostly preferred yellow coloured flowers compared to bluish-white flowers for foraging.

In present investigation, *Cissites* sp. was observed in *X. latipes* both male and female, Mite population was collected from the acarinarium of the *X. (K.) pubescens*

According to Gerling *et al.* (1989)^[4] phoretic mites were associated with *Xylocopa* sp. and transport to the nesting location of the large carpenter bee. Deutonymphs of three genera had without stigma act as phoretic viz., *Sennertia*, *Horstia* and *Torotnia* but other stages of the mites were feed on the brood feed of the *Xylocopa* sp. *Dinogamasus* mites were associated with large carpenter bee, *Xylocopa* (K.) sp. present in the abdominal pouches.

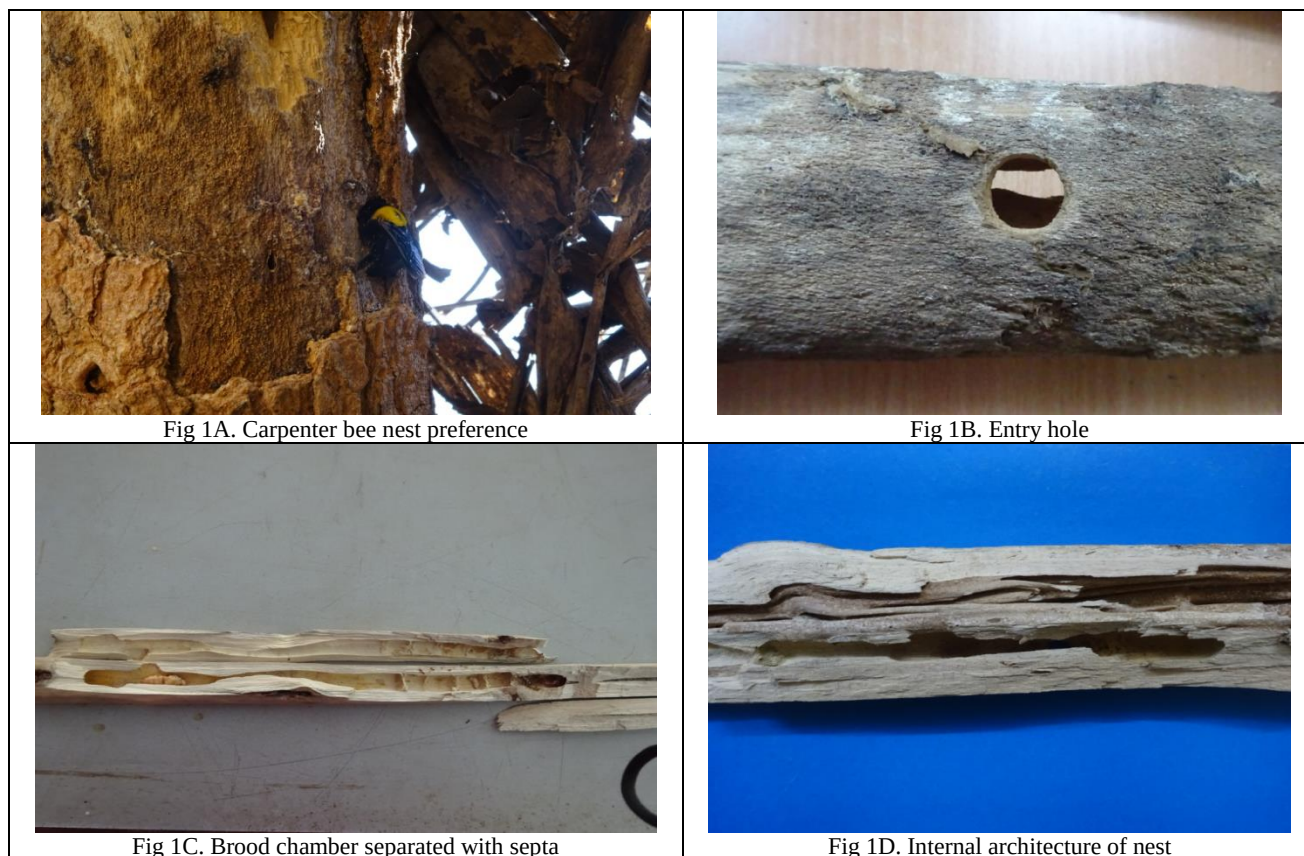


Fig 1: Nest architecture of large carpenter bee, *Xylocopa* spp.

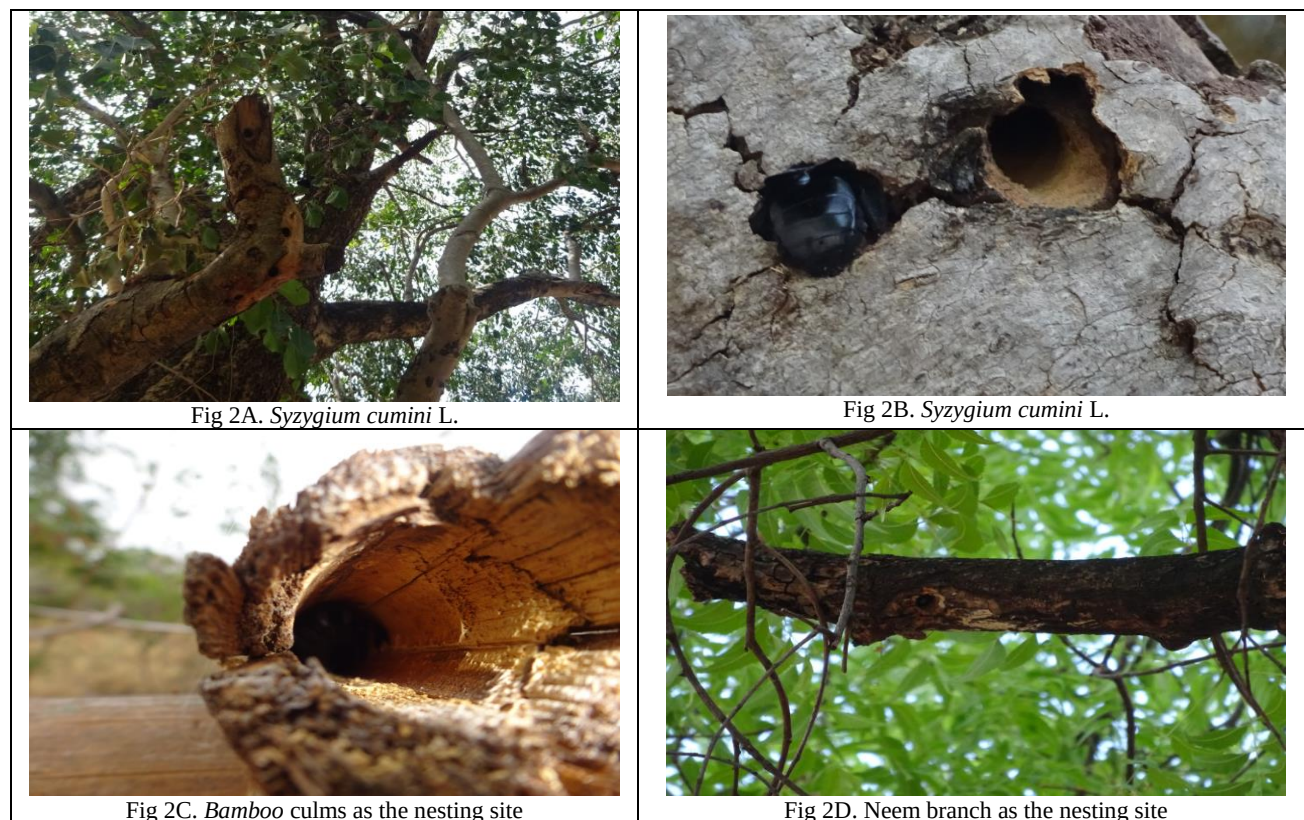


Fig 2: Natural preference of large carpenter bee, *Xylocopa* spp for nesting

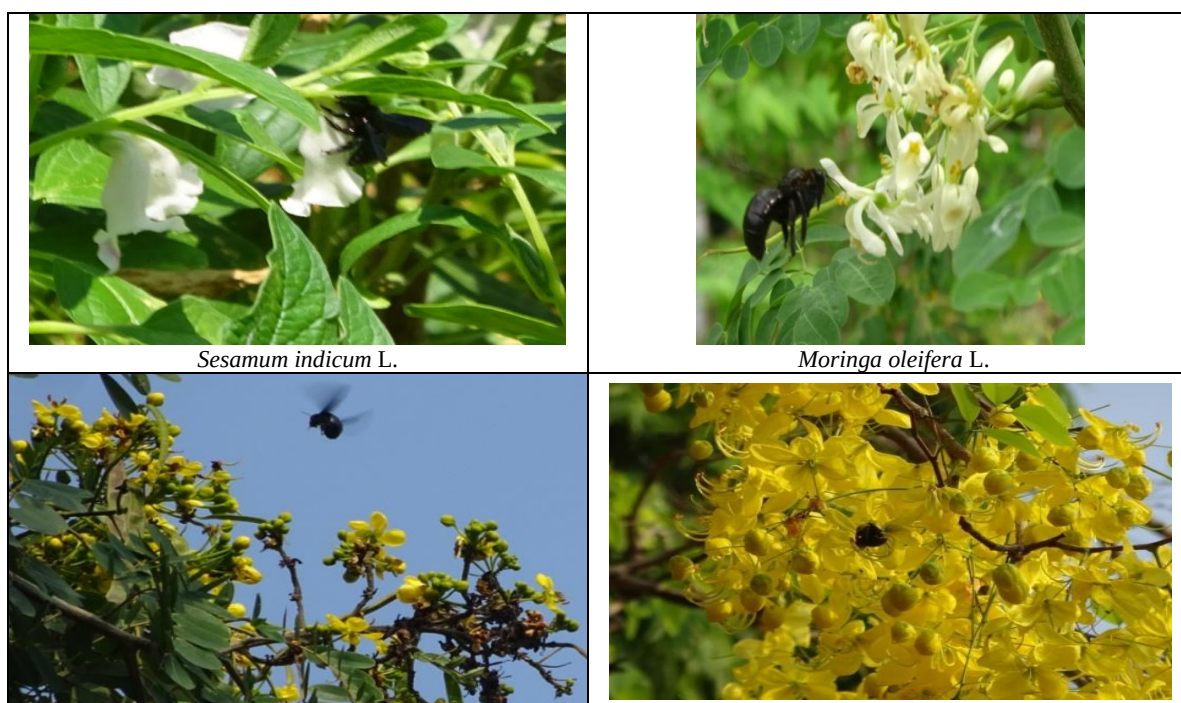
Table 1: Nest architecture of large carpenter bee, *Xylocopa* spp

Particulars	Mean $\pm$ SD	Range
Nest entrance diameter (cm)	1.25 $\pm$ 0.25 (N=8)	1-1.7
Length of the nest (cm)	23.37 $\pm$ 9.67 (N=8)	9-42
Width of the nest (cm)	1.5 $\pm$ 0.24	1-1.8
Number of cells per nest	5	5
Length of the brood cell (cm)	2.44 $\pm$ 0.66 (N=5)	1.7- 3.7
Partition thickness (cm)	0.48 $\pm$ 0.29	0.3-1
Number of adults encountered during nest examination	2.5 $\pm$ 0.5	2-3

Table 2: Preference of large carpenter bee, *Xylocopa* spp. towards cultivated, ornamental, wild flora as pollen and nectar sources

Common name of the crop plants	Scientific name	Family	Large carpenter bee spp.	Colour of the flowers	Feast collected by the bees
Red gram	<i>Cajanus cajan</i> L.	Fabaceae	<i>Xylocopa (Biluna) nasalis</i> W. <i>Xylocopa</i> sp.	Yellow	P & N
Green gram	<i>Vigna radiata</i> L.	Fabaceae	<i>Xylocopa</i> sp.	Yellow	P & N
Sunflower	<i>Helianthus annuus</i> L.	Asteraceae	<i>Xylocopa</i> sp.	Yellow	P & N
Sesamum	<i>Sesamum indicum</i> L.	Pedaliaceae		White	P & N
Brinjal	<i>Solanum melongena</i>	Solanaceae	<i>Xylocopa</i> sp.	Purple	P & N
Drumstick	<i>Moringa oleifera</i> L.	Moringaceae		White	P & N
Pomegranate	<i>Punica granatum</i> L.	Punicaceae	<i>X. (K.) pubescence</i>	Yellow	P
Indian mallow	<i>Abutilon indicum</i> L.	Malvaceae	<i>X. (P.) latipes</i> <i>X. (K.) pubescence</i>	Yellow	P & N
Cocks comb	<i>Celosia</i> sp.	Amaranthaceae	<i>Xylocopa</i> sp.	White	N
Sunhemp	<i>Crotalaria juncea</i> L.	Fabaceae	<i>X. fenestrata</i> <i>X. (K.) pubescence</i> <i>X. (P.) latipes</i>	Yellow	P & N
Giant milk weed	<i>Calotropis gigantea</i> L.	Apocynaceae	<i>Xylocopa</i> sp.	Whitish purple	N
Yellow shower	<i>Cassia fistula</i> L.	Fabaceae	<i>Xylocopa</i> sp. <i>X. (P.) latipes</i> <i>X. (K.) pubescens</i>	Yellow	N
Yellow bell	<i>Tecoma stans</i> L.	Bignoniaceae	<i>Xylocopa</i> sp.	Yellow	N
Golden dewdrop	<i>Duranta erecta</i> L.	Verbenaceae	<i>X. (K.) pubescens</i>	Purple	P
Pride of India	<i>Lagerstroemia speciosa</i> L.	Lythraceae	<i>X. (K.) pubescens</i> <i>X. (P.) latipes</i>	Purple	N
Red bell	<i>Allamanda blanchetti</i> A.	Apocynaceae	<i>Xylocopa</i> sp.	Pink	N
Cucumber	<i>Cucumis sativus</i> L.	Cucurbitaceae	<i>Xylocopa</i> sp.	Yellow	P&N
Bitter guard	<i>Momordica charantia</i> L.	Cucurbitaceae	<i>Xylocopa</i> sp.	Yellow	P&N
Bride tears	<i>Antigonon leptopus</i> H.	Polygonaceae	<i>Xylocopa</i> sp.,	Pink	N

P- Pollen; N-Nectar; P &N- Pollen and Nectar sources



<i>Cassia</i> sp. 	<i>Cassia fistula</i> L 
<i>Lagerstroemia speciosa</i> L. 	<i>Crotolaria juncea</i> L. 
<i>Calotropis gigantea</i> L.	<i>Cajanus cajan</i>

Fig 3: Foraging preference of large carpenter bee *Xylocopa* sp. On cultivated, weed and ornamental flora





Fig 4: *Cissites* sp. association with large carpenter bee, *Xylocopa* (P.) *latipes*



Fig 5: Phoretic mite associated with large carpenter bee, *Xylocopa* (K.). sp.

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