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OBSERVATIONS ON NESTING BEHAVIOUR AND NEST STRUCTURE OF THE RESIN BEE, *MEGACHILE INEPTA* CAMERON (MEGACHILIDAE: HYMENOPTERA)

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ABSTRACT
The observations on nesting behaviour and nest structure of the resin bee, *Megachile inepta* at Pantnagar revealed that this species construct its nest in hollow tunnels of bamboo stick having a diameter of 4.62 mm and tunnel length of 234.54 mm. The bee used resin to construct nest cells and resin and pebbles to plug the nest. The length of brood cells varied from 10.54 – 12.11 mm (Mean ± SD: 11.39 ± 0.59 mm; n = 6) and the thickness of cell partitions varied from 1.04 - 1.82 mm (Mean ± SD: 1.37 ± 0.29 mm; n = 6). The thickness of nest plug was 3.10 mm. The development period of the male bee of *M. inepta* was 29 days. Present observations generated base line data for understanding the nesting behaviour of *M. inepta* which would be helpful to explore the domiciliation of this species and to develop conservation strategies.

INTRODUCTION

Megachilid bees are reported to be well-known pollinators of many important plants in different parts of the world. The family Megachilidae that includes the leaf cutter bees, mason bees and the resin bees with over 4000 species, is the second largest family of the bees (Michener, 2007). The leaf cutter bee, *Megachile rotundata* is an established pollinator of alfalfa and the mason bees, *Osmia cornifrons, O.lignaria and O. cornata* are highly effective pollinators of fruit trees and used for orchard pollination (Bosch and kemp, 2002). In India, the Megachilid bees including leaf cutter bees and mason/ resin bees are found all over the country (Gupta, 2003) and the bee species, namely, *Megachile bicolor*, *M. lanata*, *M. cephalotes*, *M. albifrons* and *M. disjuncta* are reported as good and effective pollinators for almost whole of northern half of country (Gupta and Yadav, 2001; Khan and Srivastava, 2013). Data on the nesting biology are very important for revealing the potential crop pollinators and their artificial breeding (Maeta, 1978; Torchio, 1990; Lu *et al.,* 2003; Maccagnani *et al*., 2003; Ivanov and Fateryga, 2006). Still, the biology of Megachilid bees is not sufficiently studied; data on the nesting habits are available only for 1/5 of the genera of this family, whereas the biology of most species remains unstudied (Michener, 2007). Considering the pollination potential and possible role of the Megachilid bees in crop production and maintenance of plant biodiversity, detailed studies on their nesting biology and ecology are required to utilize their potential and sustaining their populations.

The nesting behaviour and plant resources of Megachilid bees in our country also has yet not been explored to a greater extent so that they can be utilized for pollination services and maintenance of existing population and to develop conservation strategies. In general, the mason or resin bees make their nests in hollow tunnel cavities and line their nests and nest cells with resin, mud, plant fibres etc. The mason bee, *M. lanata* constructed its nests with resin in hollows of bamboos and castor stems as well as in cracks and crevices (Chaudhary and Jain, 1978). The bee, *Megachile inepta* is one of the several mason bees occurring in this region. However, no reports on its nesting biology and other behavioural parameters are available so far. With a view to generate primary information about nesting behaviour and the foraging plants of the mason/ resin bee, *M. inepta* observations were recorded during 2013 and discussed in this article.

MATERIALS AND METHODS

Present studies were carried out while conducting detailed investigation on biological parameters and domiciliation of native Megachilid bee pollinators at Pantnagar. For this purpose, regular surveys at 15 days interval were conducted in different potential habitats of Megachilid bees at various centres of the University campus. These centres included Crop Research Centre, Vegetable Research Centre, Garden Section, Model Floriculture Research Centre, Agro Forestry Research Centre, University Apiary, Modern Bee Research and Training

Centre.

To explore the possibilities of domestication of various native Megachilid bees, artificial domiciliation structures following Chaudhary and Jain (1978); Wojtowski *et al*. (1995); Steffan-Dwenter and Schiele (2004) with some modifications were provided in April, 2013 at three centres namely Apiary site, Garden section and Model Floriculture Research centre. In one of the shelters, bamboo cane sticks with hollow tunnels of various diameters ranging from 3.0 – 9.0 mm having tunnel length 100 and 250 mm were placed in groups of 25-30 sticks in a triangular wooden cover named as Triangular Bee Nesting shelter. The nest constructed by Megachilid bees were observed and marked during regular survey visits. After completion of the nest making activity, the nests were covered with muslin cloth and taken to the laboratory where they were kept in suitable glass jars, to record the development period of the progeny and to study the nest structure. The developmental period was calculated from the date of plugging to the date of emergence of a particular adult bee.

The nest of *M. inepta* was opened carefully 15 days after adult emergence to study nest structure and other nest parameters. Observations on various nesting parameters such as nesting habitat, nesting substrate and nesting season were recorded on visual basis while all the measurements were recorded with digital Vernier caliper. To record floral resources of *M. inepta*, the bees visiting flowering plants in field surveys were observed and recorded.

RESULTS AND DISCUSSION

Nesting habitat, nesting substrate and nesting season

The nesting habitat of *M. inepta* was Garden section. The female of *M. inepta* bee used pre-existing tunnel of bamboo cane stick in Triangular Bee Nesting Shelter as its nesting substrate in the month of May, 2013. During nesting period the area had different flowering plants including seasonal and perennial plants, shrubs and herbs. In present studies, the nesting substrate for *M. inepta* was found in pre existing tunnel of bamboo stick. The mason bee, *M. lanata* also nests in hollows of bamboo stems as reported by Chaudhary and Jain (1978).

Nest structure and other nesting parameters

The *M. inepta* mother bee constructed its nest in horizontally placed bamboo stick having a tunnel length of 234.54 mm and entrance diameter of 4.62 mm. The hollow tunnel was lined by sticky resin material by the mother bee. The leaf cutter bee *M. rotundata* used 4.0 mm diameter tunnels for nesting (Stephen and Osgood, 1965). The shape of the cells in the nest was cylindrical or tubiform. These cells were constructed horizontally, adjacent to each other in a linear series. Total 6 brood cells were constructed, leaving an empty space of 102.89 mm in the basal side of the tunnel (Fig 1; Plate 1). For cell construction, the bee used resin and the cells were clearly separated with partitions, again constructed with resin. The cell partitions were convex on lower side and concave on upper side. The length of brood cells varied from 10.54 – 12.11 mm (Mean $\pm$ SD: 11.39 $\pm$ 0.59 mm; n = 6) and the thickness of cell partitions varied from 1.04 - 1.82 mm (Mean $\pm$ SD: 1.37 $\pm$ 0.29 mm; n = 6) while the thickness of first cell base was 3.29 mm. The length of the basal 2 brood cells was higher (12.01 and 12.11 mm) than the later 4 brood cells (10.54 – 11.35 mm). These two basal brood cells were the female bearing cells, which is a pattern similar to many other solitary bees. Stephen and Osgood (1965) also reported that the inner most cells of alfalfa leaf cutter bee usually contains females and the outermost contain males. After completion of construction of the brood cells, the mother bee blocked the nesting tunnel with 5.42 mm long layer of sticky resin, leaving an empty space of 15.02 mm from last brood cell (Fig: 1, Plate: 1). The bee finally plugged the nest at the entrance using resin and gravel (on 17th May, 2013). The thickness of nest plug was measured 3.10 mm.

Only one adult male bee emerged from this nest on 15th June, 2013. The development period of the male bee of *M. inepta* was 29 days. Examination of the nest cells after 15 days of adult male bee emergence revealed that remaining 5 brood cells had young dead larvae with fungal growth on them.

In present studies the resin bee, *M. inepta* was observed to visit 3 plant species for provision collection. These plant species were *Dalbergia latifolia* (Fabaceae), *Pongamia pinnata* (Fabaceae) and *Salvia horminum* (Lamiaceae). Earlier the resin bees, *M. lanata* and *M. disjuncta* have been reported to visit

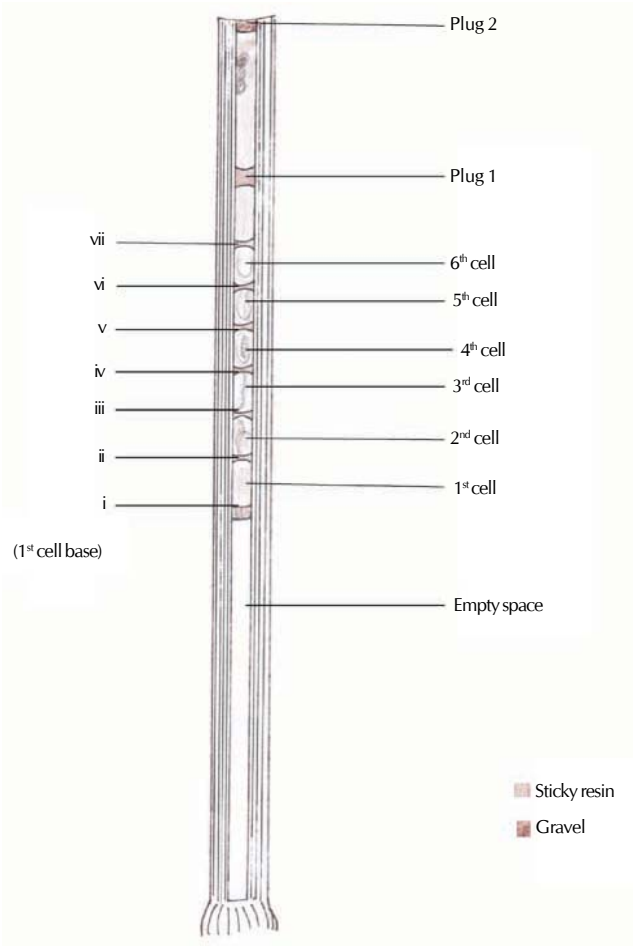

Figure 1: Line diagram of *M. inepta* nest: ii-vii: cell partitions; i: cell base

Megachile inepta showing nest plug

Nest of *Megachile inepta*

Plate 1: Nest plug and nest of *Megachile inepta*

Caesalpinia crista (Neli and Kalita, 2013) and mustard (Goswami and Khan, 2014), respectively. The provision found in the nest cells of *M. inepta* in present studies was similar to other Megachilid bees, made of pollen and nectar as young larvae only have a liquid diet but as they grow and consume the provision the diet progressively increased in pollen content (Klostermeyer *et al*., 1973).

Present observations on the nesting behaviour and nest structure of *M. inepta* revealed that *M. inepta* is a solitary bee of mason group of Megachilidae family which constructed its nest in hollow tunnel of bamboo stick with resin and plugged its nest using resin and pebbles. O'Toole and Raw (1991) also reported that the mason bees use mud, resin, pebbles and plant hair to line the nests, construct cells, partitions and plug. The foreign material (resin) used by the Megachilid bees has been reported to be hydrophobic and shows antimicrobial activity (Messer, 1985; Muller *et al.,* 1996). The cell construction behaviour of *M. inepta* was found similar to *Osmia dimidiata* in sense that this species also nest in available cavities as in reed stems with 1- 9 cells (Ivanov *et al.,* 2013).

Present investigations is the novel study that generated primary observations and scientific data on the nesting and nest structure of the resin bee, *M. inepta* and is the foremost report on this megachilid bee pollinator. The results would specifically help to understand its behaviour and possibilities for its domiciliation in future and develop conservation strategies.

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