N O T E

Trap-Nest Diameter Preference of *Megachile lanata* (Hymenoptera: Megachilidae)[1]

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Megachile lanata F. is a major solitary bee pollinator of many agricultural crops (Mattu and Kumar 2016, Intern. J. Sci. Res. 5: 456–458; Singh 2016, Russian J. Ecol. 27: 310–314). Adult females of the genus *Megachile* use leaf pieces to construct nests in preexisting cavities, hollow stems, dead woods, and man-made holes. Leaves are cut by the females to line their cells, creating multiple layers of leaf, and the female bees lay their eggs inside the leaf cell preprovisioned with pollen (Torretta et al 2012, Apidologie 43: 624–633).

Artificial trap nests constructed of wood are commonly used to study the biology, population dynamics, and diversity of the leafcutting bees. Trap nesting also has been used as a tool to assess impacts of habitat quality, habitat fragmentation (Steffan-Dewenter 2003, Conserv. Biol. 17: 1036–1044), and landscape complexity on cavity-nesting bee communities in agro-ecosystems (Frankie et al. 1993, Environ. Entomol. 27: 1137–1148; Kremen et al. 2012, Proc. Nat. Acad. Sci. USA 9: 16812–16816; Krusses and Tscharntke 2002, Conserv. Biol. 16: 1570–1580; Strickler et al. 1996, J. Kansas Entomol. Soc. 69: 26–44).

Nesting habitat plays a vital role in sustaining the population of native solitary bees, and intensive agricultural practices cause loss of natural habitats and plant diversity thereby negatively impacting solitary bee populations. Cavity-nesting bees belonging to the family Megachilidae are an easily managed group of pollinators with potential to be utilized for domestication using trap nests and plant sources for pollination (Neil and Neil 2013, Proc. Entomol. Soc. Wash. 115: 158–166.). Successful utilization of solitary bees in crop pollination depends upon knowledge of the nest preference and nesting biology. Nest dimensions are vital to the nesting success of the bees as well as progeny body size, sex ratio, and rate of survival (Bosch and Kemp 2002, Bull. Entomol. Res. 92: 3–16). We conducted this study

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with the aim of understanding the preference of nest diameter on the rate of acceptance and biological parameters of the megachilid bees.

The study was conducted on the farm at the Indian Council for Agricultural Research, National Bureau of Agricultural Insect Resources on the Bengaluru, Yelahanka Campus (N 13°5′48.5″, E 77°33′57.5″) from July 2016 to May 2017. The study area covered 8.9 ha with cultivated field and orchard crops and two patches of pollinator gardens of about 0.6 ha with over 100 plant species representing diverse plant families. This farm is located in a rapidly growing urbanized area.

Trap nests were constructed using the stems of bamboos of different diameters (5.0, 10.0, 15.0, 20.0, 25.0 mm) which were replicated five times with 10 nests per replicate. Each trap nest was split longitudinally into two halves, and the two halves were then held together using tape to facilitate examination of the nest contents once accepted by the bees. Nest bundles were wrapped using plastic cord, and the traps were secured to branches of randomly selected trees. All traps were placed at a height of 1.5 m above the ground. The nests were inspected weekly, and occupied nests were marked with the observation date allowing determination of time taken by the bees to occupy the nest and percentage of nest acceptance.

Occupied nests were transported to the laboratory and maintained in mesh cages and periodically observed until the emergence of adults. The number of nest cells formed, rate of emergence, and number of females that emerged were recorded. Emerged adult bees were identified using taxonomic keys. Ten days after the emergence of the bees from the trap nests, the nests were opened to examine the presence of any parasites or evidence of parasitism of the immature stages of the bees. Cause for any observed mortality was also recorded. Analysis of variance (GLM in SAS 9.3; SAS Institute, Cary, NC) was used to compare the effect of cavity diameter on number of cells formed and adult female bee emergence. Percentage data were subjected to arcsine transformation before analysis. Where significant difference was detected, treatment means were separated using Tukey's HSD (0.5%).

Rate of acceptance by the leafcutting bees differed significantly among the trap diameters ($F = 20.33$; df = 4, 16; $P < 0.0001$) with the highest percentage of acceptance recorded in the smallest nest diameter tested (5 mm; 60.1%), followed by the 10-mm (46%) and the 15-mm (24.22%) treatments. Only 2% of the largest-diameter nests (25 mm) were accepted by the bees. Barthell et al. (1998, Environ. Entomol. 27: 240–247) also reported the highest rate of trap acceptance by *Megachile angelarum* Cockerell, *Megachile fidelis* Cresson, and *Megachile gentilis* Cresson of trap nests measuring 5 to 8 mm in diameter, while Zillikens and Steiner (2004, J. Kansas Entomol. Soc. 77: 193–202) found that *Megachile pseudanthidioides* Moure preferred wooden boxes with an internal cavity diameter of 10 mm for nesting, and MacIvor and Packer (2015, PlosOne 10: 122–126) observed that 81.3% of *Megachile campanulae* (Robertson) and 60.2% of *Megachile rotundata* F. successfully nested in man-made "bee hotels" of 5.5-mm-diameter tubes.

An inverse relationship between number of cells constructed and nest cell diameter was observed with the fewer cells constructed in the larger-diameter openings. The bees accepted the trap nests of 5.0-mm diameter in a mean of 17 d compared to the larger-diameter nest of 25.0 mm in a mean of 48.6 d. Time taken in construction of the nests was less in the smaller-diameter trap nests than the larger-diameter nests, which might be attributed to the fewer number of foraging trips needed for collection of leaf material to construct their nests. Interestingly, the leaf material used to construct cells varied among the nests of the different nest trap diameters although the nests were placed in the same experimental site.

Trap-nest diameter also significantly affected emergence of the bees from the nests ($F = 27.57$; df $= 4, 16$; $P < 0.0001$) with the highest number of bees (31.2) emerging from the smaller-diameter nests and the least number (2.4) from the largest-diameter nests. In the trap nests with smaller diameters, bees used relatively smaller-sized leaf bits to construct and cap the cells than they used with larger-diameter nests. The lower number of cells constructed in the trap nests of larger diameter might coincide with the low emergence of the bees from larger-diameter nests. The bees may require a relatively larger-sized leaf bit and a higher cost of energy for constructing its cell in the larger-diameter trap nests in comparison to the smaller-diameter trap nests.

The total number of females emerging from trap nests also differed significantly with nest diameter ($F = 16.68$; df $= 4, 16$; $P < 0.0001$), with the highest number emerging from the larger nest diameter of 5.0 mm (20.8) followed by 10.0 mm (14.4), 15.00 mm (10.40), 20.0 mm (8.0), and 25.0 mm (0.8). The number of male bees that emerged was also significantly higher in the smaller diameter of 5.0 mm (10.4) compared to the larger diameter of 25.0 mm (1.60). The sex ratio was found to be female-biased in the smaller-diameter trap nests, a likely positive attribute in sustaining the population. Brood parasitism by *Celioxys* sp. was observed in only few of the nests and was not related to trap-nest diameter. Based on the results of this preliminary study, bamboo trap nests of 5.0–10.0 mm diameter could be used to conserve and augment the leafcutting bee, *M. lanata*, in semiurban and urban habitats for their valuable pollination service.