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BRIEF COMMUNICATION

Unusual nesting behavior in *Megachile* (*Eutricharaea*) *rotundata* (Hymenoptera: Megachilidae)

Cory S. Sheffield[1]

Abstract. The Alfalfa Leafcutter Bee, *Megachile* (*Eutricharaea*) *rotundata* (Fabricius), is one of the most studied solitary bees in the world. Although its nesting biology is well documented, it has not yet been reported nesting in cavities that expose the nests to open environments. Reported here for the first time is evidence of this species nesting in an unusual manner which would subject the natal cells to exposure and increased parasite attack.

Bees of the genus *Megachile* Latreille *s.l.* (Hymenoptera: Megachilidae) are commonly called leafcutters as females of most species cut circular leaf pieces, less commonly flower petals (*e.g.*, Orr *et al.*, 2015), or combinations of materials (*e.g.*, Zillikens & Steiner, 2004) that are used in the construction of individual natal cells (Fig. 1), each of which will contain one developing bee. Other species of *Megachile* are masons or daubers, creating nest partitions out of plant resins or similar pliable materials (Michener, 2007; MacIvor & Moore, 2013). Leafcutter bees will construct nests in a variety of places, including cavities excavated into the soil (Eickwort *et al.*, 1981) or decomposing wood (Hobbs & Lilly, 1954; Stephen, 1956), but most species nest in natural pre-existing cavities in wood, stone, or other substrates; see Sheffield *et al*. (2011) for a summary of nesting sites used by species occurring in Canada. Regardless of the nesting substrate used, female leafcutter bees normally exhibit the behavior of building and provisioning their nests in a linear series, with eggs destined to become females being laid first (*i.e.*, at the rear of the rear of the series in the nesting cavity), with males being produced towards the nest entrance. Male post-diapause development is faster than for females (Sheffield, 2008), allowing them to exit the nesting cavity before their sisters. An interesting exception was noted by Packer (1987) who reported on exposed single-celled nests of *Megachile pseudobrevis* Mitchell in apical tufts of grass in Florida.

[1] Royal Saskatchewan Museum, 2340 Albert Street, Regina, SK S4P 2V7, Canada (cory.sheffield@gov.sk.ca).
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Figure 1. A natal cell of the Alfalfa Leafcutter Bee, *Megachile rotundata* (Fabricius) (Megachilidae) constructed with many individual leaf pieces. The apical (*i.e.*, flat end to the left) is where the bee's head is, and is the direction of exiting from the cell.

Many of the species of *Megachile* that nest in pre-existing cavities will utilize artificial nesting substrates (*e.g.*, Fye, 1965; Krombein, 1967; Stephen & Every, 1970; Sheffield *et al*., 2008, MacIvor & Packer, 2015; MacIvor, in press), popularly called bee condos or hotels (*e.g.*, Ravoet *et al*., 2014; MacIvor & Packer, 2015; Fortel *et al*., 2016), or trap/cavity nests (*e.g.*, Koerber & Medler, 1958; Medler & Koerber, 1958; Krombein, 1967; O'Neil & O'Neil, 2016; MacIvor, in press). In these artificial nesting sites, the nesting cavities are typically pre-constructed to run horizontally and perpendicular to the nest front surface, though this arrangement may not always be available in natural cavities. The diameter of the individual tunnels can vary to support occupant diversity (*e.g.*, Tscharntke *et al*., 1998; Sheffield *et al*., 2008), and influence sex-ratio for target species (*e.g.*, Stephen & Osgood, 1965).

The use of artificial nesting sites for cavity nesting bees has greatly enhanced our knowledge of the biology of many species, including the economically important Alfalfa Leafcutter Bee, *M*. (*Eutricharaea*) *rotundata* (Fabricius) (Pitts-Singer & Cane, 2011). This species is not native to North America, but is commercially very important for the pollination services it provides to several crops, including alfalfa, canola, and lowbush blueberry (Richards, 1984; Sheffield, 2008; Pitts-Singer & Cane, 2011). One of the key life history traits promoting the successful management of *M. rotundata* is that it will nest in large aggregations containing 1000s of individuals. For commercial pollination, nesting populations are provided with artificial nesting substrates (Stephen, 1961), usually created with polystyrene (Richards, 1978) placed within a shelter. As this species has become established throughout most of southern Canada (Sheffield *et al*., 2011), it will still use a range of natural and artificial pre-existing cavities (Sheffield *et al*., 2008), and will often be one of the most numerous nest occupants where it has established (MacIvor & Packer, 2015).

Reported here for the first time is evidence that *M. rotundata* may be more flexible in its choice of nesting substrates and nesting behavior than previously thought. While visiting the Creston Museum in Creston, British Columbia, I observed and pho-

Figures 2–5. Nesting location of a population of *Megachile rotundata* (Fabricius) (Megachilidae) in the radiator of a Caterpillar™ tractor. **2.** Entire radiator surface. **3.** Section of radiator showing many linear series of natal cells. **4.** A female constructing a natal cell with a leaf piece. **5.** The likely emergence hole from previous generation; note the emergence hole is on the lateral surface of the cell, not the apical end.

tographed (with an iPhone 5s™) a nesting population of *M. rotundata* building nests in the radiator of an antique Caterpillar™ farm tractor that was on display (Figs. 2–5). Nests were constructed in the typical linear fashion within these pre-existing cavities, each running parallel with the surface of the radiator (Fig. 3). Unusual was the fact that nest construction was done with approximately half of the lateral surface of each natal cell exposed to the external environment (*e.g.*, light, temperature/sunlight, rain), and likely parasites. One of several such parasites is the chalcid wasp *Pteromalus apum* Retzius (=*Pteromalus venustus* Walker), a very important pest in commercial operations rearing *M. rotundata* populations (Hobbs & Krunic, 1971). Adult wasps emerge and re-infect the un-emerged hosts during incubation, which are still in their cocoons but loose in large rearing containers (*i.e.*, within a 21 day period). If unchecked, the parasites of *M. rotundata* have the ability to quickly reduce the population of bees available for pollination, so various methods of pest control are used (Eves, 1970).

The conditions observed in commercial rearing facilities are seldom observed in nature, as almost all cavity-nesting bee species will utilize pre-existing cavities that are linear and of a small diameter, with only the apical end of the outermost cell being exposed at any given time. However, the nesting behavior observed in Creston would make these bees more susceptible to parasite attack throughout nest construction as a large area of each cell was exposed. In a study of nesting in the subgenus *Moureapis*

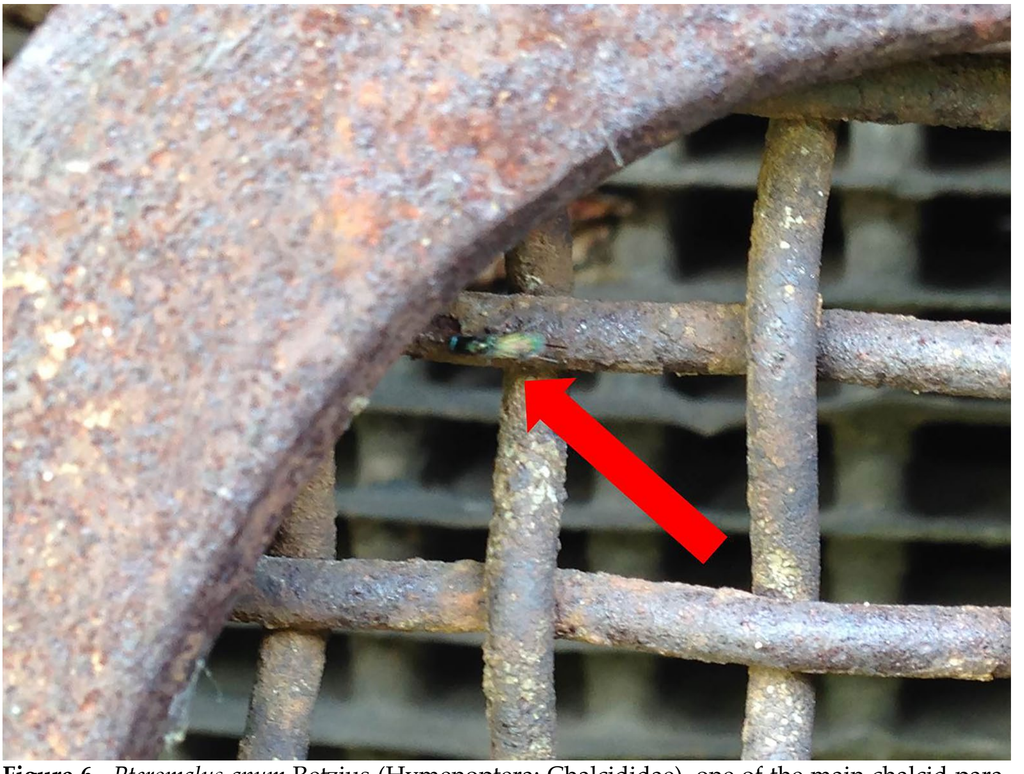

Figure 6. *Pteromalus apum* Retzius (Hymenoptera: Chalcididae), one of the main chalcid parasites of the Alfalfa Leafcutter Bee. Several adult *P. apum* were observed near the bee nesting population.

Raw, which tend to prefer to nest in much wider cavities, a number of the linear series of nests in each cavity had high numbers of hymenopteran and dipteran parasites, and psocopteran nest associates (Cardoso & Silveira, 2010). Similarly, the exposed nests of *M. pseudobrevis* reported by Packer (1987) contained meloid beetles. Although the population in Creston was not followed to document mortality, a number of females of *Pteromalus* were observed at the nesting sites (Fig. 6). In natural nesting cavities, one would expect that individual natal cells are only subject to attack from parasites while the nest is being provisioned, though in thin-walled nesting cavities, some parasites (*e.g.*, *Leucospis affinis* Say) can penetrate the lateral walls (Graenicher, 1906; Medler & Koerber, 1958). Also typically observed is that the occupants emerge from the apical end of the natal cell, with individuals normally emerging from the apical to rear end of the nest (so as not to chew through their siblings). In the nests in Creston, emergence holes were observed on the lateral edges of the leaf cells (Fig. 5), though these may have been from previous years, as females of this species are attracted to odors from old nests (Pitts-Singer, 2007), or from an earlier generation that year (Tepedino & Parker, 1986). Although cavity-nesting bees will nest in a variety of cavities under natural settings, the flexibility reported in this study suggests that the Alfalfa Leafcutter Bee may also accept sub-optimal nesting sites. This species also will accept a range of other artificial nesting cavities, including plastic straws, which have been shown to significantly decrease bee survival due to mold growth (Stephen & Every, 1970). Plasticity in other aspects of nesting in this species, including the use of cut plastic bags instead of (or in addition to) leaf pieces, has also been observed (MacIvor & Moore, 2013), though the long-term impacts of such material on bee survival need to be further evaluated.

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