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Parasitisation of leaf-cutter bees (Megachilidae: Apoidea) by *Melittobia*

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ABSTRACT: Megachilid bees play an important role in pollination of many domesticated and wild plant species. During our attempts to trap nest these bees in southern India, we observed a heavy parasitisation by a species of Melittobia (belonging to *Melittobia hawaiiensis* species group) (Hymenoptera: Eulophidae). Out of 173 megachilid cells collected from 29 nests belonging to four species, 148 cells were parasitized by *Melittobia* sp., with an average of 85.55 % parasitisation and not a single bee emerged from 55.17% of the nests. This is the first record of *Melittobia hawaiiensis* species group parasitizing *Megachile* spp. in India.

KEYWORDS: *Melittobia hawaiiensis* species group, Pollination, Parasitization, Megachile, trap-nests, Bee-hotels

INTRODUCTION

In recent years, there has been an increasing concern on declining pollinator populations, in both natural and agricultural ecosystems (Biesmeijer *et al*., 2006; Potts *et al*., 2010). This decline could be a result of indiscriminate pesticide use (Kremen *et al.* 2002), habitat fragmentation (Mustajarvi *et al*. 2001; Aguilar *et al.* 2006) and/or intensified cultivation practices (Tscharntke *et al.* 2005; Ricketts *et al.* 2008). It is an established fact that pollinating agents are essential for the survival and reproduction of several wild and cultivated plant species (Kearns *et al*., 1998; Klein *et al*., 2007). Among the 18,000+ species of bees in the world, Megachilidae, forms a major group of solitary bees (Michener, 2007), which are involved in pollination of a variety of wild and cultivated plants. The role of leaf-cutter bees as major pollinators of alfalfa, blueberries and pigeon pea has been well established (McGregor, 1976; Free, 1993; Prashanth and Belavadi, 2015).

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To enhance pollination service by leaf-cutter bees, there have been several studies on using artificial nests for increasing their populations (Krombein, 1967; Bohart, 1972; Gaston *et al.,* 2005; Bird, 2010; Pitts-Singer and Cane, 2011). Trap nests, in addition to being excellent nesting sites, may also become attractive to parasites, since a large number of brood cells will be available close to one another (MacIver and Packer, 2015). In the present study we examine the parasitisation of trap nesting Megachile spp. in south India.

MATERIAL AND METHODS

For intensive collection of megachilids, we had placed a total of 117 hollow reeds of *Ipomoea carnea* Jacq. (Fig. 1) for trap nesting leaf-cutter bees on GKVK campus of the University of Agricultural Sciences, Bangalore, India. Fifty reeds were placed on 20.05.2013 and 67 reeds on 1.8.2014. The reeds that were occupied were brought to the laboratory and each reed nest was given a unique number and placed in a separate transparent enclosure. Observations were recorded on the number of cells per nest, number of leaf-cutter bees and parasites emerging from each nest. Voucher specimens of the parasitoid and the leafcutter bees have been deposited in the collections of the Department of Entomology, University of Agricultural Sciences, Bangalore, India. Additional specimens of the parasitoid have been deposited with the National bureau of Agricultural Insect Resources, Bangalore, India.

RESULTS AND DISCUSSION

A total of 29 reeds (24.78%) were occupied by four species of megachilids, viz., *Megachile lerma* Cameron, *M. lanata* (Fab.), *M. disjuncta* (Fab.) and one unidentified species of *Megachile*. The number of cells per nest was 5.96 ± 1.52 (3 to 9; n = 29). One or all the cells in all the nests of these bees were parasitized by a species of *Melittobia* (Fig.2, 3) (Eulophidae: Hymenoptera). A total of 6,022 adults of *Melittobia* emerged from 148 cells with a mean of 43.98 ± 16.20 per cell (range: 20.86 to 94.33; n = 148 cells) (Table 1).

Table 1. Extent of parastisation by *Melittobia* on *Megachile* spp.

***Megachile* species**	**# of Nests**	**# of cells**	**# of cells parasitized**	**# of cells *Melittobia***	**# of cells *Melittobia* / cell**	**# of LCB adults emerged**
M. lerma	3	18	13	647	49.77	5
M. lanata	6	40	30	1581	52.70	10
M. disjuncta	1	9	3	163	54.33	6
Megachile sp1.	3	13	9	515	57.22	4
Megachile spp.*	16	93	93	3116	33.51	0
Total	**29**	**173**	**148**	**6022**	**40.69**	**25**

*Since all cells in the 16 megachilid nests were parasitized, the host species could not be ascertained

The parasitoid was identified as a member of *Melittobia hawaiiensis* species group based on the following characters: facial grooves convergent above middle of eyes; scape and pedicel clearly paler than flagellum; head relatively narrow, head length greater than genal width; eyes densely clothed with long setae, setae scattered; clypeal margin bilobed and without undulation; nipple on club/claval segment 3, long with one subterminal seta, subterminal seta basal in location; terminal seta on postmarginal vein noticeably longer than those on marginal vein; submarginal vein with 5 long setae; sculpture pattern on mesoscutum and scutellum mid lobes open, particularly on scutellum.

According to Dahms (1984), *Melittobia hawaiiensis* is a complex, and this species group needs detailed morphometric analysis.

Of the four species of leaf cutter bees, *M. lanata* recorded the greatest parasitisation (54.55%) with 1581 parasitoid adults emerging from 30 cells with an average of 52.7 per cell. 72.22 per cent of the 18 cells constructed by *M. lerma* were parasitized by *Melittobia,* with 647 adults emerging from 13 cells with an average of 49.76 per cell. From among the cells of the unidentified species of *Megachile*, a total of 515 parasitoid adults emerged from 63.88 per cent of the cells with a mean of 57.22 per cell. Lowest parasitisation was recorded in *M. disjuncta* (33.33%) with only 163 parasitoid adults emerging from three cells (54.33/cell). From the remaining 16 nests (93 cells) only *Melittobia* adults emerged indicating 100 per cent parasitisation (Table 1; Fig. 4). A total of 3116 parasitoid adults emerged from these nests with an average of 33.50 per cell. On an average, 40 *Melittobia* adults emerged per cell, irrespective of the species of *Megachile* (Fig. 5). This is the first record of *Melittobia hawaiiensis* species group parasitizing *Megachile* spp. in India.

Fig.1 Reeds of *Ipomea cornea* used for trap nesting *Megachile* spp.

Fig. 2 Adult female *Melittobia* sp.

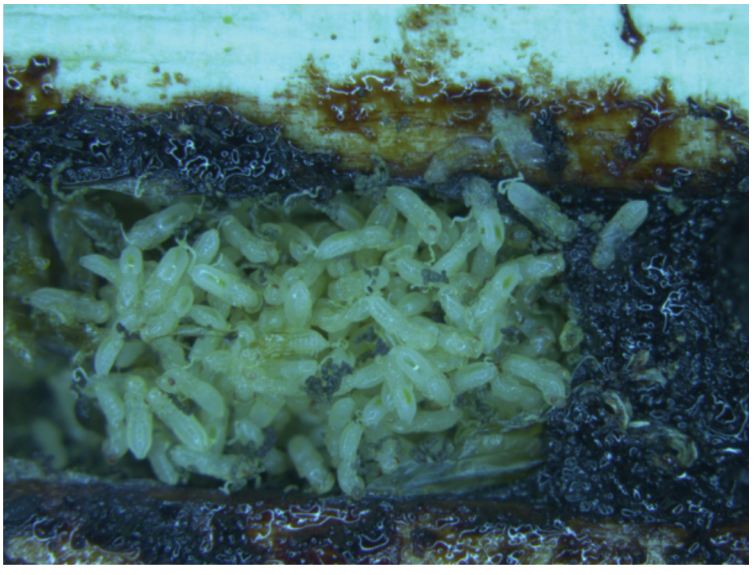

Fig. 3 Prepupae of *Melittobia* sp. in a leaf cutter bee cell

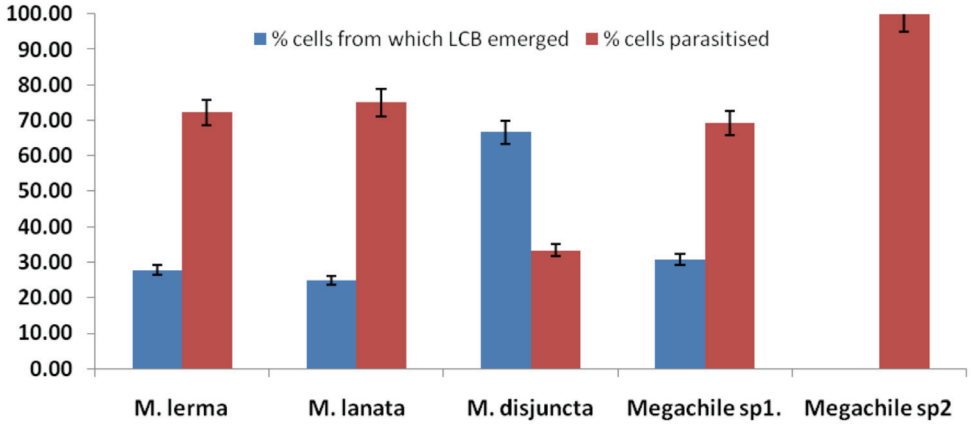

Fig. 4 Percent parasitisation by *Melittobia* and percent survival of *Megachile* spp.

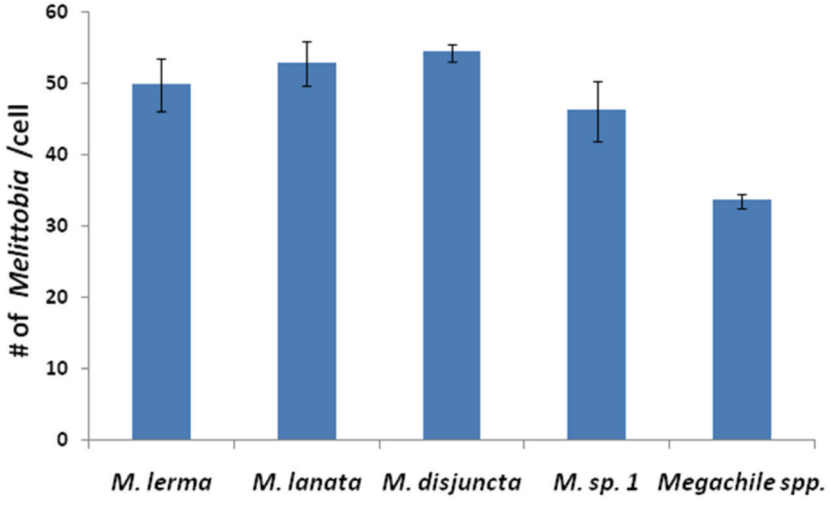

Fig. 5 Number of *Melittobia* adults emerging per cell of *Megachile* spp.

Melittobia spp. have been recorded as important parasitoids of bumble bee colonies and leaf cutting bees in Great Britain, Russia, USA, New Zealand, Japan and Finland (Gonzalez *et al*. 2004; Mathews *et al.,* 2009). *Melittobia hawaiiensis* has been recorded parasitizing *Melitoma segmentaria* (Emphorini: Apidae) in Argentina (Aquino *et al.,* 2015). From India two species of *Melittobia* are recorded- *Melittobia acasta* (Walker) belonging to "*acasta* species group" and *M. assemi* Dahms belonging to "*assemi* species group" (Narendran, 2007). *Melittobia acasta* was found parasitizing *Bombus hortorum* (L.) and *B. ruderatus* (F.) colonies, and *Melittobia* occurred annually in almost all leaf cutting bee nests and killed 64% of 8,370 cells (Macfarlane and Donovan 1989), and also was found parasitic on *Megachile relativa* Cresson in Canada (Dahms, 1984). *Melittobia acasta* parasitized 48.6 per cent of *Megachile rotundata* cells in Hungary (Farkas and Szalay, 1985). *Melittobia digitata* Dahms*, M. australica* Girault, *M. hawaiiensis* Perkins*,* and *M. femorata* Dahms parasitized *Megachile rotundata* in the US (Deyrup, 2005).

The extent of parasitization observed in the present study appears alarming, since 85.55 percent of the bees were killed by *Melittobia* sp. with only 25 leaf cutter bees completing their development out of 173 cells. Though trap nesting has been recommended to increase pollinator nesting sites and for conserving pollinators (Gaston *et al.*, 2005; Tscharntke *et al.,* 1998; Steffan-Dewenter, 2002), Maclvor and Packer (2015) caution us on excessive use of trap nests (which they call 'Bee Hotels'), as the bees and wasps nesting in trap nests may be more prone for parastisation. Our studies on *Melittobia* parasitisation on *Megachile* spp. show exactly this. The very high parasitisation (85.55%) may be because the reeds used for trap nesting were placed in clusters of 15 to 20, and it was easy for the parasites to locate their hosts. Hence, it may be necessary to distribute the trap nests in smaller clusters. Since leaf cutter bees are important pollinators of pigeon pea (Prashanth and Belavadi, 2014) and of several other crops (Abrol, 2012) in India and other parts of the world, it may be important to protect these bees from parasite attacks as well.

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