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Nesting biology of the leaf-cutter bee *Megachile centuncularis* (L.) (Hymenoptera: Megachilidae) in Britain

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ABSTRACT. The construction and provisioning of twelve nests in the field and six nests in an insectary by the leaf-cutter bee, *Megachile centuncularis* (L.) in Britain are described. The bees nested in lengths of bamboo cane of 7mm to 11mm internal diameter provided for them. In an insectary, females spent on average 9¾ hrs building and provisioning each cell: they averaged 21 trips to construct a cell and 18 to provision it with food. The mean proportions of time spent on collecting pieces of leaves, constructing the cell, foraging and provisioning it were 4%, 11%, 75% and 11% respectively. Hence, the fecundity rate of nesting females probably depends very much on food availability.

Nests in the field were provisioned with pollen from 28 plant families. Cells contained, on average, pollen from 7 families with the most common one averaging only 58.1%. However, pollen of Compositae, Caryophyllaceae and Papilionaceae represented >80% of the pollen sampled. The wide floral range of *M.centuncularis* is probably an important factor influencing the species' success in inhabiting suburban environments.

Key words: *Megachile centuncularis,* leaf-cutter bee, insectary observations, cell building, cell provisioning, types of pollen

Introduction

The leaf-cutter bee, *Megachile centuncularis* (L.), is the type species of a genus of more than two thousand species. It is locally common in England in woodland clearings and suburban gardens with a variety of summer flowering plants and seems particularly well adapted to the latter habitat. The female builds her nest in existing cavities. There are records of nests in old beetle burrows in wood and even in soil (Shuckard, 1866; Smith, 1876; Saunders, 1986; Yarrow, 1943).

Data are presented here on twelve nests built at four localities around Hertfordshire, England. In addition observations were made on five females that nested in an insectary at Rothamsted Experimental Station, Harpenden, Hertfordshire, England.

Observations

During the present study, bamboo canes of 7mm to 11mm internal diameter and 100m long were provided as nest sites in the field which the bees readily accepted; five bees also nested in similar canes in an insectary (measuring 4m × 3m × 2.5m) where plentiful supplies of building materials and flowers were provided.

Six canes were split open and some leaf pieces cut away so that the sequence of emergence of the 25 bees that emerged could be observed. In only one nest did the bees become active in the same order in which they left the nest. Ten bees were disturbed when their siblings behind them bit through the cocoon and nipped them – as has been reported for the emergence of *Osmia rufa* (L.) (Raw, 1972).

M. centuncularis is univoltine. Emergence time varies from year to year depending on ambient temperature but in southern England bees emerged during the last two weeks of June and the first of July. Males emerged up to four days before females. (The females were located in cells towards the back of the nest.)

Adult males were active for up to three weeks and spent much of their time searching for females around flowers; adult females were active for up to seven weeks.

On selecting an empty cane, a bee built a cell at the closed end. The females constructed each cell with leaf pieces, provisioning it with food, laying an egg on the provisions and sealing the cell with more leaf pieces. The closure of one cell formed the base of the next. After completing two to five cells, a bee plugged the nest entrance with additional leaf pieces and began searching for an empty cane.

The mean number of cells in 12 nests built in the field was 4.5 (S.E. ±0.2). In each nest examined, females were located in the first cells built. There was no significant difference between the lengths of the cells containing either sex [11.1mm (S.E. ±0.5) females; 10.1mm (S.E. ±0.4) males].

TABLE 1. Mean lengths of time *Megachile centuncularis* females (n = 5) spent constructing and provisioning cells in an insectary.

	Building	*Provisioning*
Number of cells	10	5
Mean number of trips per cell (& S.E.)	21.5 (±1.3)	18.0 (±0.6)
Mean period per collecting trip	1m 2s	24m 15s
Mean period per visit to nest	2m 12s	3m 34s
Mean period feeding and resting per cell	14m 32s	–
Mean total period per cell	1h 24m 3s	6h 31m 149s

The construction of ten cells and the provisioning of them by five females in the insectary were observed (Table 1). Females cut circular and oval pieces of leaves with which the cells were lined. It was not clear if the bee secreted a substance to glue the pieces of leaves together but, on drying, they adhered to one another. In the field, bees commonly use pieces of rose leaves, so rose branches were provided in the insectary used by the bees in addition to *Melilotus altissima* (Thuill) already growing there. Bees averaged 3 min 14 sec to select a leaf, cut off a piece, fly with it to the nest and position it in the cell. While engaged in cell construction, they frequently interrupted their activities to feed from flowers, this activity averaging 17% of the total time spent in constructing the cell. Bees spent most of their active time in provisioning the cell with pollen (average 75% of their time). The time spent to deposit the food in the cell on each visit was 1.6x longer than to place a piece of leaf.

The total mean period spent in the construction and provisioning of a cell was 9 hr, 44 min, 45 sec. The mean periods spent on collecting pieces of leaves, constructing the cell, foraging and provisioning the cell were 3.8%, 10.6%, 74.6% and 11.0% respectively. In July and August in England, adult *M. centuncularis* are active from about 08.00 to 19.00 so they completed about one cell per day depending on the weather.

After the larvae had finished feeding and spun their cocoons, some uneaten pollen was usually lodged in the cracks between the leaves lining the cells. Samples of these residues were obtained from 42 cells provisioned in the field. The actions of both the provisioning adult female bee and the larva mixed the pollen so the samples are considered to be representative of all the pollen deposited in the cell.

In each sample, 500 grains were identified as far as possible (Table 2). Of the 28 plant families represented, Compositae, Caryophyllaceae and Papilionaceae accounted for >80% of the total pollen sampled. The most popular family was Compositae and included *Taraxacum officinale* Weber, *Sonchus, Chrysanthemum, Centaurea, Cosmos* spp., *Calendula, Bellis perrenis* L. and *Helianthus annuus* L. Pollen of *Dianthus* (Caryophyllaceae), *Lotus, Melilotus* and *Trifolium* (Papilionaceae) were common.

On average, there were 7.1 (S.E.±0.2) plant families represented per cell and the most frequent plant family per cell averaged only 58.1%.

In the insectary, the bees visited all the flowers provided. They foraged mostly on *Melilotus altissima* (Papilionaceae), but also on *Circium arvense* (L.) and *Sonchus oleraceus* (L.) (Compositae) and *Cheiranthus allionii* (Hort.) (Cruciferae).

The bees development in 54 cells was followed. Thirty eight bees emerged while six eggs, five larvae, one prepupa and four adults died in the cells. The causes of death were not identified. Of the 38 adults that emerged, 18 were females and 20 males.

TABLE 2. The types of pollen sampled from 42 cells of *Megachile centuncularis* in southern England. (500 grains were identified in each sample. Genera are listed where >90% of the total grains of the family are from plants of a single genus.)

Taxon of pollen	mean %
Ranunculaceae (*Aquilegia*)	0.8
Nymphaeaceae (*Nymphaea*)	0.1
Cruciferae	2.8
Violaceae (*Viola*)	0.1
Cistaceae (*Helianthemum*)	0.8
Caryophyllaceae (*Dianthus*)	18.0
Tiliaceae (*Tilia*)	0.4
Malvaceae (*Malva*)	<0.1
Linaceae (*Linum*)	0.1
Aceraceae (*Acer*)	0.1
Papilionaceae	11.3
Rosaceae	0.1
Onagraceae	0.6
Umbelliferae	<0.1
Cucurbitaceae (*Bryonia dioica*)	0.3
Polygonaceae	<0.1
Ericaceae	<0.1
Polemoniaceae (*Polemonium caeruleum*)	0.7
Convolvulaceae	<0.1
Scrophulariaceae (*Linaria* & *Antirrhinum*)	4.5
Labiatae	2.2
Campanulaceae (*Campanula*)	1.3
Caprifoliaceae	<0.1
Dipsacaceae	2.4
Compositae	51.3
Liliaceae (*Lilium*)	1.9
Iridaceae (*Iris*)	<0.1
Graminae	0.2

Discussion

All twelve nests built and provisioned in the field and the nests of five females in the insectary were typical of *Megachile centuncularis,* with every cell being lined entirely with leaf pieces. In contrast, Markowsky (1933) reported a nest of in which the cell linings were omitted and only the circular discs separating the cells were presents.

The mean time bees spent per foraging trip (24 min 15 sec) was within the range of 10.3 mim to 29 min Michener (1953) reported for *Megachile brevis* Say, but is more than twice that spent by *Osmia rufa* — either in the field or in an insectary (Raw, 1972).

In the insectary, all the necessary resources were located within three metres of the nests and the bees built and provisioned one cell per day. While the tasks of bringing materials to the nest presumably take longer in the field where the distances are greater, *M. centuncularis* probably works at a similar rate to *O. rufa*. Of the total time bees spent constructing a cell, *M. centuncularis* averaged 17% feeding and resting, whereas *O. rufa* averaged 13% (Raw, 1972).

Both *M. centuncularis* and *O. rufa* spend much more of their time collecting food for their cells than in all other activities. Hence, the number of eggs a female of either of these species lays depends very much on the availability of food.

The nesting females of *M. centuncularis* visited numerous taxa of plants every day — as seen in the varied types of pollen present in each cell. The bees nest in suburban gardens where many species of plants are cultivated and large numbers of them flower in mid summer when the bees are active. This polylectic behaviour is probably an important factor in the species' success in inhabiting suburban environments.

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