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New localities and nesting behaviour of the solitary bee *Megachile ligniseca* (Hymenoptera, Megachilidae)

Marta Heroldová[1*], Jan Zejda[2], Petr Raus[3], František Gregor[4]

[1]*Department of Forest Ecology, Faculty of Forestry and Wood Technology, Mendel University, Zemědělská 3, 613 00, Brno, Czechia; * e-mail: marta.heroldova@mendelu.cz (corresponding author)*

[2]*Institute of Vertebrate Biology AS CR v. v. i., Květná 8, 603 65 Brno; e-mail: zejdajan@seznam.cz*

[3]*Petr Raus, Senior researcher, Antonínská 8, 602 00 Brno*

[4]*František Gregor, Senior researcher, Loosova 14, 658 00 Brno*

Heroldová M., Zejda J., Raus P. & Gregor F. 2021: New localities and nesting behaviour of the solitary bee *Megachile ligniseca* (Hymenoptera, Megachilidae). *Acta Musei Moraviane, Scientiae biologicae* **106(2):** 357–363. – Two new localities of the solitary bee, *Megachile ligniseca* (Kirby, 1802) were described in Czechia. In both cases, the nest was found on the inflorescence stem of onion plants (*Allium* sp.) in vegetable gardens. The first garden was surrounded by vineyards, arable fields and abandoned plots within the agricultural landscape of southern Moravia. The second was in a garden allotment in the centre of the city of Brno. Details described at both localities include the percentage of onion stems occupied as well as other characteristics of nesting behaviour (location of nests in inflorescence, nest size and number of cells, nesting material composition with respect to utility, etc.). Results show a great adaptability and variability of the species' nesting behaviour in response to various environmental conditions.

Keywords. solitary bee, *Megachile ligniseca*, new localities, nesting behaviour, plant material

Introduction

In recent years, insect pollination has become threatened in Europe due to habitat loss driven by agricultural intensification and due to changes in agricultural practices including the use of pesticides, herbicides and fertilisers (Heneberg *et al.* 2019). Other negative influences include urban development and climate change. These shifts explain why pollinators, especially wild bee species, have received increased attention. Close to nature habitats or abandoned land are the common habitats used by these species. These plots are mostly unsuitable for intensive farming, which allows for the development of shrubs with the plant species composition of semi-natural grassland (Nielsen *et al.* 2012). One bee species of interest, which is distributed across Europe and Asia, is the Wood-Carving Leaf-Cutter bee *Megachile ligniseca.* This species was recorded in Moravia, Czechia and Slovakia by Přidal (2004), but its occurrence is rare, and it is listed as a threatened species in Czechia (Farkač *et al.* 2005). Other data mentioning this species can be found in Kocourek (1966), Bogusch *et al.* (2007) and Macek *et al.* (2010). This bee is a summer-flying species that nests in cavities and holes within various types of timber or standing deadwood. Nests can be found in the tunnels of wood-boring insects (i.e. *Cossus cossus* – carpenter moth), in the hollow stems of plants and shrubs, abandoned nests of other bees or wasps (Westrich 1996; Amiet *et al.* 2004).

The long-tongued bees of this family cut portions of leaves as construction material for their nests; females of this group have pronounced mandibles for this purpose. The leaves are used to create divides between brood cells and to line the outer walls of the nests. *Megachile* females carry dry pollen on brushes of hairs on the underside of their abdomen and not on their hind legs like most bees (O'Toole & Raw 2004).

Nests are long columns of cells which are built from the deepest part of the space outwards. The female places food (pollen/nectar mix) and an egg into each cell. The larva hatches from the egg and consumes the provided food supply. After several months of development, it emerges from the nest as an adult. Males are smaller and emerge prior to females, dying soon after mating. Females live for a few weeks while they build new nests (Cane 2007; Michener 2007; Danforth *et al.* 2019).

Megachile ligniseca feed on many species of plants especially those with larger flowers. It also utilizes the bramble, thistles and wild rose sp. which grow on abandoned fields. Thus, this species is important in the pollination of many wildflowers (Gresty *et al.* 2018).

There is limited information about the nesting biology of many bee species, including their substrate preferences, due to the surprisingly limited attention they have received. Here we identify and describe two new localities of *M. ligniseca* bee in Moravia and detail its nesting behaviour.

Material and Methods

The first locality where the bee was observed is in the intensively utilized agricultural landscape of South Moravia, in a part of the local biocentre close to the village Nosislav (49.025998, 16.657 648). The biocentre comprises large vineyards (45% of the area) and old, abandoned fields and gardens (35%) with old fruit trees and shrubs. The dominant species in the locality are wild rose (*Rosa canina* L.), winter flame (*Cornus sanguinea* L.*),* English hawthorn (*Crataegus laevigata* L.), common hazel (*Corylus avellana* L.), blackthorn (*Prunus spinosa* L.) and elder (*Sambucus nigra* L.). The remainder (20%) of this locality is covered by intensively managed arable fields. The vegetable garden (20 x 10 m) was situated at the edge of one vineyard.

The second locality described is within a group of garden allotments in Kraví Hora district in the centre of the city of Brno (49.201 963, 16.591 542). A great variety of plants grows in this locality including trees, bushes, garden vegetables and flowering plants. This particular garden is richly covered by bramble species (*Rubus fruticosus* L. and *R. idaeus* L.).

Bee species were identified according to the bee identification keys provided for Europe (Banaszak & Romasenko 1998; Amiet *et al.* 2004). Additionally, specimens were verified in the bee collection at the Department of Entomology, Moravian Museum, Brno. The nomenclature follows the same literature as used for identification.

Bee nests were located in newly developed flowering stems of onion plants (*Allium cepa* and *A. fistulosum*). We first measured the stem from the outside with its entrance opening and its location on stem. After this the stalks were taken from the garden and placed on a tray by an open window to pass through holometabola transition and imago hatching. Hatching order of individuals, as to sex, was not recorded. Four adults were captured for species identification – three females and one male. Three of them were entomologically prepared and one male was portrayed by a scientific artist (Fig. 1). Later, we measured the location of the nest from the inside and counted the number of cells. *Megachile ligniseca* is one of the largest *Megachile* species. The size of its body is between 15 to 18 mm, with wing length to 10 mm (https://sites.google.com/site/natureguideuk/home/bees/megachile/megachile-ligniseca). All measurements were taken with an accuracy of 0.5 mm. The plant species used for nesting was determined by analysing material under a binocular microscope.

Megachile ligniseca individuals, which were entomologically prepared, will be deposited at the Department of Entomology, Moravian Museum, Brno, Czechia.

Results and Discussion

In both localities, the bee species present was determined to be *M. ligniseca* (Fig. 1). Nests of the bees were found in the Nosislav locality during the second half of May 2006. Bees occupied six of the 13 onion plants (*Allium cepa* L.) with newly developed flowering stems. As it had not been recognized initially, one stalk was opened to reveal the nest of a solitary bee. The nest was freshly completed, and all plant material was still green. In order to understand the needs and environmental requirements of the bee, the onion flower stems were measured in detail (Tab. 1). Five of the nests were described and whole stalks were taken to the laboratory at the end of May. The first bees leaving the stem were observed the same year in mid-July. The empty stems were then opened, and the cells were counted (Tab. 2). The numbers of previously occupied cells were easily recognized by cocoon material left behind.

Table 1. Description of *Allium cepa* stem used by *Megachile ligniseca* for nesting.

Flowering stem	1	2	3	4	5	Mean	Unit
Total height of stem with inflorescence	94.0	80.0	110.0	92.0	81.0	90.8	cm
Height of bee inlet above ground	80.0	46.0	60.0	60.0	40.0	57.2	cm
Thickness at base of stem	32.0	31.0	29.0	24.0	20.0	27.2	mm
Maximal thickness of stem	33.0	32.0	30.0	25.0	30.0	30.0	mm
Thickness of stem at bee inlet	14.0	14.0	18.0	10.0	11.0	13.4	mm
Length of hole in stem axis	9.5	15.5	25.0	17.8	13.0	16.2	mm
Width of hole	5.5	6.5	7.0	5.5	6.5	6.2	mm

Table 2. Description of *Megachile ligniseca* nests in stem of *Allium cepa.*

Nest	1	2	3	4	5	Mean	Unit
Distance of nest from inlet hole	23.0	12.0	40.0	20.0	20.0	23.0	mm
Length of the nest	12.0	20.0	26.0	12.0	20.5	18.0	cm
Number of cells	6.0	8.0	15.0	6.0	9.0	9.0	pc
Number of leaf slices around the cells	147.0	163.0	261.0	82.0	190.0	169.0	pc
Number of leaf slices forming a cell	8–13	9–12	8–12	9–10	10–12	8–12	pc
Number of leaf slices forming the cap	3–4	3–5	3–6	4–6	3–4	3–6	pc

Table 3. Description of *Allium fistulosum* stem used by *Megachile ligniseca* for nesting.

Flowering stem	1	2	3	Mean	Unit
Total height of stem with inflorescence	57.0	47.0	53.0	52.3	cm
Height of bee inlet above ground	25.0	25.0	26.0	25.3	cm
Thickness at base of stem	20.0	18.0	21.0	19.7	mm
Maximal thickness of stem	25.0	28.0	24.0	25.7	mm
Thickness of stem at bee inlet	15.0	17.0	15.0	15.7	mm
Length of hole in stem axis	14.0	15.0	15.5	14.8	mm
Width of hole	7.0	6.0	7.0	6.7	mm

Table 4. Description of *Megachile ligniseca* nests in stem of *Allium fistulosum*.

Nest	1	2	3	Mean	Unit
Distance of nest from inlet hole	15.0	12.0	40.0	21.3	mm
Length of the nest	10.0	11.0	15.0	12.0	cm
Number of cells	9.0	4.0	11.0	8.0	pc
Number of leaf slices around the cells	150.0	122.0	193.0	155.0	pc
Number of leaf slices forming a cell	8–13	9–12	8–12	8–13	pc
Number of leaf slices forming the cap	3–6	4–6	3–4	3–6	pc

The nesting bee roughened the inside wall of the onion stems to enable nest-building in upright stems (not visible from the outside). Leaves of plants with trichomes were collected and fixed together to fasten the nest to the stem wall. A similar ratio of plant material was used in all nests; about 50% of the plant material was *Corylus avellana* and the other 50% comprised *Fragaria vesca* and *Rubus caesius*. Only the caps of nest cells were made from *Rosa canina*, which has fewer trichomes.

In the locality in the centre of Brno, nests were found in the inflorescence stalk of a different onion (*Allium fistulosum* L.). Nests of the bees were found at the first half of May 2015. Out of the 10 stalks present, only three (30%) were occupied by bees. Due to prior identification of the inlet holes, flowering stems were left on the plants and nest details were described after the bees had exited (Tabs 3 and 4). Bees were observed in Brno cutting the leaves of *Rubus fruticosus* and *R. idaeus* (both species with trichomes) in the garden; several specimens were captured to confirm the plant species identification. The origin of all nesting material was determined as *Rubus* sp. Some of the cells were found unoccupied but containing provisions. The contents appeared to be a mixture of honey and pollen (pollen was confirmed under the microscope but the plant species was not identified). These uninhabited cells at the end of the nest may be used by the mother bee to protect the larvae against parasites (MALYSHEV 1935). *M. ligniseca* was found to be host of a rare cleptoparasitic bee *Coelioxys alata* Förster, 1853 (BOGUSCH 2005; 2020). As the onion stems were easy to bite through, some of the bees exited the nest directly from their cells. This exiting behaviour was observed three times in Nosislav and twice in Brno. The first cells of the nest were always built in a narrower portion of

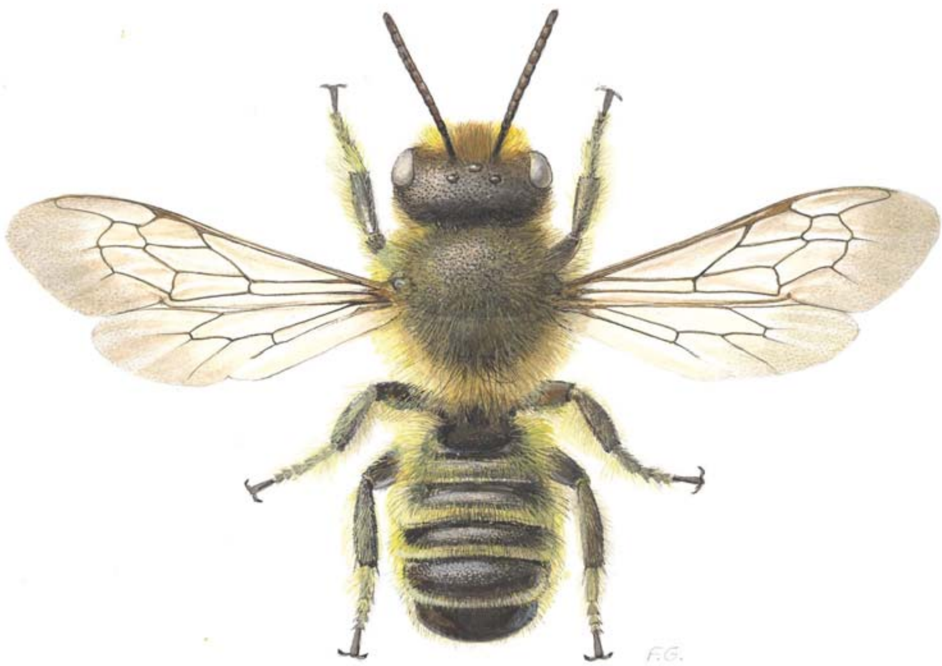

Fig. 1. *Megachile ligniseca*, male (painted by František Gregor), according to collected individual.

the stem, even if it was followed by a broader segment of stem. In broader stretches of the stem, bees must collect much more material (leaf slices) to fill the gap. The size of the leaf slices in both onion sp. were similar (n = 300 pc for both), varying in length 12.0 to 18.0 mm (mean 15.0 mm±1.3) and in width 7.0 to 11.0 mm (mean 8.8 mm±1.0). The length of each nest depended on the amount of leaf pieces used to firmly attach the base to the wall of the onion stem as well as on how many cell caps were used to divide the individual cells. The size of the cells was similar in both onions sp., the height of the cell was (n=68 measured) 13 to 15 mm (mean 14) and width was (n=68) 5 to 6 mm. Data from MALYSHEV (1935) and CANE *et al.* (2007) similarly describe the material used for bee nests (though for other species), finding a wide variability in solitary bee nesting behaviour.

Private gardens are an abundant resource for pollinators. Gardens benefit bees and enhance pollination in intensively managed farmland (SAMNEGÅRD *et al.* 2011, MAJEWSKA & ALTIZER 2018). Additionally, the plots set-aside under European Union agri-environmental efforts also contribute to the protection of native flora and fauna (SCHEPER *et al.* 2013). GRESTY *et al.* (2018) used sequencing of 164 pollen samples extracted from the brood cells of six common cavity-nesting solitary bee species including *M. ligniseca*. This revealed the herb species on which they forage. *Rosa canina* L. was the most commonly found of the 23 plant species identified in the pollen samples. The frequent use of the plant suggested it being an important forage plant for these species. In order to support a diverse community of pollinators in European farmland, additional plant species such as *R. canina* should be included in wildflower seed mixtures to meet the foraging requirements of solitary bees. *R. canina* was an abundant species in both localities of this study.

Pollination by bees fertilises plants, facilitating sexual reproduction. The ubiquity of bees and their close association with flowering plants makes them a keystone species in the dynamics of global wild and agricultural ecosystems. 35% of global agricultural production comes from crops that depend primarily on insect pollinators. Out of the 124 main crops grown for global human consumption, 87 (70%) require insect pollination to produce seeds and to improve product quality and yields (e.g. many fruit trees, nuts) (Garratt *et al.* 2014).

Some improvement in our agricultural landscapes should be achieved by increasing landscape diversity while stressing the role of wild flower strips, hedges and wooded habitats for the enhancement of wild bees diversity (Scheper *et al.* 2013; Bogusch *et al.* 2020; Kordbacheh *et al.* 2020). According to Bogusch (2005), *M. ligniseca* was also found in wet habitats in higher elevations, which was confirmed by Přidal (1998) in the locality Bílé Karpaty. *M. ligniseca* shows high adaptability to variable environmental conditions, in terms of the nesting cavities as well as the nesting material used. We expect to find stable populations of the species in more diverse and close-to-nature environments in Czechia.

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