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Megachile (*Callomegachile*) *sculpturalis* Smith, 1853 (Apoidea: Megachilidae): a new exotic species in the Iberian Peninsula, and some notes about its biology

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Abstract

The exotic bee *Megachile sculpturalis* has colonized the European continent in the last decade, including some Mediterranean countries such as France and Italy. In summer 2018 it was recorded for the first time in Spain, from several sites in Catalonia (NE Iberian Peninsula). Here we give details on these first records and provide data on its biology, particularly of nesting and floral resources, mating behaviour and interactions with other species.

Key words: Hymenoptera, Megachilidae, *Megachile sculpturalis*, exotic species, biology, Iberian Peninsula.

Resum

***Megachile* (*Callomegachile*) *sculpturalis* Smith, 1853 (Apoidea: Megachilidae): una nova espècie exòtica a la península Ibèrica, amb notes sobre la seva biologia**

L'abella exòtica *Megachile sculpturalis* ha colonitzat el continent europeu en l'última dècada, incloent alguns països mediterranis com França i Itàlia. A l'estiu de 2018 es va detectar per primera vegada a Espanya, a diversos llocs de Catalunya (NE península Ibèrica). En aquest article aportem informació sobre aquests primers registres i dades sobre la seva biologia, en particular sobre els recursos nidificants i florals, el comportament d'aparellament i les interaccions amb altres espècies.

Paraules clau: Hymenoptera, Megachilidae, *Megachile sculpturalis*, espècie exòtica, biologia, península Ibèrica.

Introduction

Megachile sculpturalis Smith, 1853, commonly known as the giant resin bee (Fig. 1a, b), belongs to the family Megachilidae and is native to the Eastern Palaearctic. It is included in the subgenus *Callomegachile* Michener, 1962 a group of large (18-39 mm in length) bees with sizeable mandibles that nest in pre-existing aerial cavities and use resin, wood fibres, pieces of leaves and clay to make brood cells and nest closures (Michener, 2000).

Megachile sculpturalis was first recorded as an exotic species in North America in 1994, where it is now widely distributed (Mangum & Brooks, 1997; Parys *et al.*, 2015). Over the past decade it has begun to colonize Europe and, to date, it has been recorded in France (Vereecken & Barbier, 2009; Le Féon *et al.*, 2017), Switzerland (Amiet, 2012), Italy (Quaranta *et al.*, 2014), Hungary (Kovács, 2015), Germany (Westrich *et al.*, 2015) and, most recently, in Austria (P. Westrich *in* Le Féon *et al.*, 2017).

Due to its nesting behaviour, it has been suggested timber trade as the most plausible explanation for this species' colonization beyond its native range (Quaranta *et al.*, 2014); however, the great dispersal capacity its large body size can afford might also help to explain its rapid expansion (Greenleaf *et al.*, 2007).

Here we report the first records of this exotic species in the Iberian Peninsula and provide some data on its biology, morphology and behaviour.

Table 1. Location of sites and dates of observations of *Megachile sculpturalis* Smith (1853) in Catalonia in 2018. The general habitat of each site is also specified.

Site	*Town*	*Lat.*	*Long.*	*Altitude (m a.s.l.)*	*Date of observation*	*Habitat type*
1	Sant Celoni (Vallès Oriental)	41º41'30''N	2º29'46''E	143	5-23.VII.2018	Private urban garden
2	Sant Celoni (Vallès Oriental)	41º41'31''N	2º29'42''E	154	23.VII.2018	Private urban garden
3	La Garriga (Vallès Oriental)	41º41'98''N	2º17'29''E	252	29.VII.2018	Private urban garden
4	Olot (Barri de Pequín) (Garrotxa)	42º10'17''N	2º28'43''E	441	13-20.VII.2018	Private urban garden
5	Olot (Can Llambrich-Bosc de Tosca) (Garrotxa)	42º09'16''N	2º29'27''E	495	31.VII.2018	Oak (*Quercus robur* L.) forest

Material and methods

Study sites

In July 2018, we recorded *M. sculpturalis* from several sites in Catalonia (NE Iberian Peninsula, Spain) (Table 1). Except for one site in an oak forest, where it was nesting in the porch of an old isolated house, all records of this bee are from private gardens in towns or villages.

Biological data

Some sites were visited several times to record information on the phenology, nesting, foraging and mating behaviour. We also collected several individuals for morphological measurements and to analyse pollen use. We brushed fuchsine-stained gelatine on bees' scopae, which were then mounted on a slide (Beattie, 1971) for subsequent pollen counting and identification. Collected material is deposited in the collections of the following institutions: CREAF, Centre de Recerca Ecològica i Aplicacions Forestals (Cerdanyola del Vallès, Spain); MNHN, Museo Nacional de Historia Natural de Madrid (Madrid, Spain); MCNB, Museu de Ciències Naturals de Barcelona (Barcelona, Spain); Museu de Ciències Naturals de Granollers.

Results

Phenology and general behaviour observed

The first report of the presence of *M. sculpturalis* was from Site 1 on July 5th, 2018. On the morning of July 23th, with fair weather conditions, we observed bee activity, paying special attention to nesting and foraging behaviour and possible interactions with other species. We recorded 20 females entering and leaving the nests, either collecting and provisioning brood cells with pollen and nectar or nest-building. The same day, a single nesting female was captured in the garden of a nearby house (Site 2).

In the Olot area, we were alerted by the owners of the building at Site 4 about the presence of insects around rotten wood on their porch on July 9th. On July 13th, 32 individuals (13 males and 19 females) were captured and confirmed as giant resin bees. Measurements of these individuals are given in Table 2. No males were seen on a visit two weeks later.

On July 31th we visited a new location in Olot (Site 5) in light of information from a landowner. Only females were observed on a porch, where they were nesting in cavities of beams of *Robinia pseudoacacia* Linnaeus (Fabaceae).

Finally, a single female was found drowned in a swimming pool in La Garriga on July 29th (Site 3).

Table 2. Measurements (in mm) of 32 individuals of *Megachile sculpturalis* Smith (1853) captured at Site 4. Thorax width (i.e. the distance between the distal extremes of the tegula) is the best predictor of the minimum diameter needed for a cavity to be used as a nesting site.

Individual	*Sex*	*Wingspan*	*Body length*	*Intertegular span*	*Thorax width*
1	Female	40	25	6	9
2	Female	40	24	6	9
3	Female	40	24	6	9
4	Female	39	25	6	8
5	Female	38	25	6	8
6	Female	40	26	7	9.5
7	Female	40	26	6	9
8	Female	38	24	6	8
9	Female	39	23	6	8
10	Female	39	24	6	9
11	Female	40	25	7	9
12	Female	36	21	6	8
13	Female	38	23	6	9
14	Male	32	12	5	7
15	Male	33	19	5	7
16	Male	33	18	5	7
17	Male	27	14	4	6
18	Male	36	22	5	7
19	Male	36	18	5	7
20	Male	36	18	5	7
21	Male	36	19	5	8
22	Male	36	19	5	7
23	Male	34	18	5	7
24	Male	32	17	5	7
25	Male	33	18	5	7
26	Male	33	17	5	7
27	Male	34	18	5	7
28	Male	33	17	5	7
29	Male	33	18	5	7
30	Male	32	16	4	6
31	Male	33	17	4	6
32	Male	31	16	4	6

Floral resources and pollen use

Flowers of the exotic tree *Styphnolobium* (= *Sophora*) *japonica* Linnaeus (Fabaceae) were by far the most abundant trophic floral resource in the proximity of the *M. sculpturalis* nests at Site 1. In fact, although we inspected flower patches in the surrounding areas (all of which were ornamental plants), we only found *M. sculpturalis* foraging on *S. japonica* flowers (10 individuals on a tree 10m far from the nest, and one individual on a tree 100m far from the nest). The ventral scopae of individuals provisioning brood cells were full of orange-coloured pollen.

We captured five females to analyse their use of pollen. In four out of five individuals, 100 % of the pollen transported was from *S. japonica*. In the fifth bee, *S. japonica* pollen accounted for 96 %, the rest being from *Lagerstroemia* sp. (Lythraceae) (3 %) or *Ligustrum* sp. (Oleaceae) (1 %). The number of pollen grains counted per individual in two replicated standardized samples was as follows: 229 and 419 grains (individual 1), 255 and 178 (individual 2), 99 and 76 (individual 3), 192 and 123 (individual 4), 183 *S. japonica* + 5 *Lagerstroemia* sp. grains, and 136 *S. japonica* + 3 *Lagerstroemia* sp. + some *Ligustrum* sp. grains (individual 5).

At Site 4, the ornamental exotic trees *Ligustrum lucidum* W.T. Aiton and *Lagerstroemia* sp. were in bloom on July 13th and 31th, respectively, but no visits by giant resin bees were recorded. Visits were neither recorded on a patch of *Lavandula* sp. growing in a nearby garden. *Lavandula* is commonly visited by *M. sculpturalis* in France (Le Féon *et al.*, 2017), but here was chiefly visited by wild bees such as *Bombus lucorum* Linnaeus, 1761*, B. pascuorum* Scopoli, 1763, *Anthidium florentinum* Fabricius, 1975 and *A. manicatum* Linnaeus, 1758. However, the pollen grains from one female giant resin bee were counted and analysed, and they were found to correspond to *Ligustrum vulgare* Linnaeus (479 grains, 76 %), *Ligustrum* sp. (most possibly, *L. lucidum*: 138 grains, 22 %), and *Lavandula* sp. (13 grains, 2 %). *M. sculpturalis* females were also observed carrying unidentified yellow and orange pollen in their ventral scopae at Site 5 (Fig. 1c).

Nesting resources, nest structure and mating behaviour

At Site 1, the giant resin bees nested in 20 × 10 mm brick holes at a height of 2,5 m^2 (NW and SE orientation). We found 17 nests that were finished and recently closed (with an extremely hard resin covered with clay) out of a total of 250 potential holes (Fig. 1d, e). Individuals building nests transported resin, mud and wood fibres in their mandibles (Fig. 1f, g). Nests under construction were supplied with an orange-coloured pollen, as well as with the nesting material lining the hole and the brood-cell enclosures. Resin was usually used to line the base, and a mixture of mud and wood fibres was placed in front of the material supplied.

On July 14th, we recorded intense activity by flying females at Site 4, which were searching for suitable nest cavities in rotten wooden beams (Fig. 1h); just a few were making provisioning trips and carrying pollen or a whitish resin. Two females were captured carrying flowers of *Sambucus nigra* Linnaeus in their mandibles, and another nesting female was observed entering an ancient nest-hole reminiscent of a *Xylocopa* Latreille, 1802 nest. However, most of the bees observed were males searching for females at the nesting sites (Fig. 1i). Around 10 males were patrolling simultaneously around one cavity looking for emerging females, and one mating pair was seen in flight near this cavity. Some males displayed competitive behaviour involving bumping heads against the body of conspecifics.

At Site 5, we saw several females sharing a cavity under a wooden beam (Fig. 1j), but we were unable to confirm whether or not they were nesting communally using the same new perforated gallery, a behaviour that has been recorded in the related species *Megachile pluto* B. Smith ex Wallace, 1860 (Michener, 2000). Other females were using another hole on the opposite side of this beam. Interestingly, on July 31th various females were observed visiting a planted fir tree (*Abies alba* Mill.), and two were later captured carrying resin from this tree for nest construction. Other females were observed collecting resin from a peach tree (*Prunus persica* (Linnaeus) Stokes).

Lastly, a quite different nest substrate –a hole in a corrugated plastic tube containing an electric cable– was detected for the single female at Site 2.

Interactions with other species

At Site 1, the flowers of *S. japonica* –virtually the only floral resource used by *M. sculpturalis*– were also visited by several other insects: of these, the honeybee *Apis mellifera* Linnaeus, 1758 was by far the most abundant, followed by the bumblebee *Bombus terrestris* Linnaeus, 1758, the carder bee *A. florentinum*, the carpenter bee *Xylocopa violacea* Linnaeus, 1758 and the butterfly *Lampides boeticus* Linnaeus, 1767. *Anthidium florentinum* was nesting gregariously at the same nesting site as *M. sculpturalis*, but less abundantly. However, we observed no aggressive interactions between these two species.

At Site 5, several small Gasteruptiidae (Hymenoptera: Parasitica) were noted very close to the nest entrances. In the Olot area these parasitoids are usually found in small nests of *Hylaeus* sp. (Apoidea: Colletidae) and *Heriades* sp. (Apoidea: Megachilidae) (Osorio *et al.*, 2015).

Discussion

Our observations, together with those by Ortiz-Sánchez *et al.* (2018) from Barcelona, Girona and the village of Riudarenes, represent the first records of this Asian species in the Iberian Peninsula and a south-westward expansion of its range in continental Europe.

Invasive species are the second greatest threat to biodiversity worldwide (Bellard *et al.*, 2016). Specifically, exotic bee species alter native pollinators' behaviour, thereby causing changes in the structure of plant-pollinator networks and, ultimately, affecting native bee populations and pollination function (Traveset & Richardson, 2006). *Megachile sculpturalis* is known to be the first exotic bee species to colonise continental Europe (Le Féon *et al.*, 2017).

Although the bibliography shows that *M. sculpturalis* is a polylectic species (Quaranta *et al.*, 2014; Parys *et al.*, 2015), our observations of its foraging behaviour and pollen analyses suggest that, if available, the species has a strong prefer-

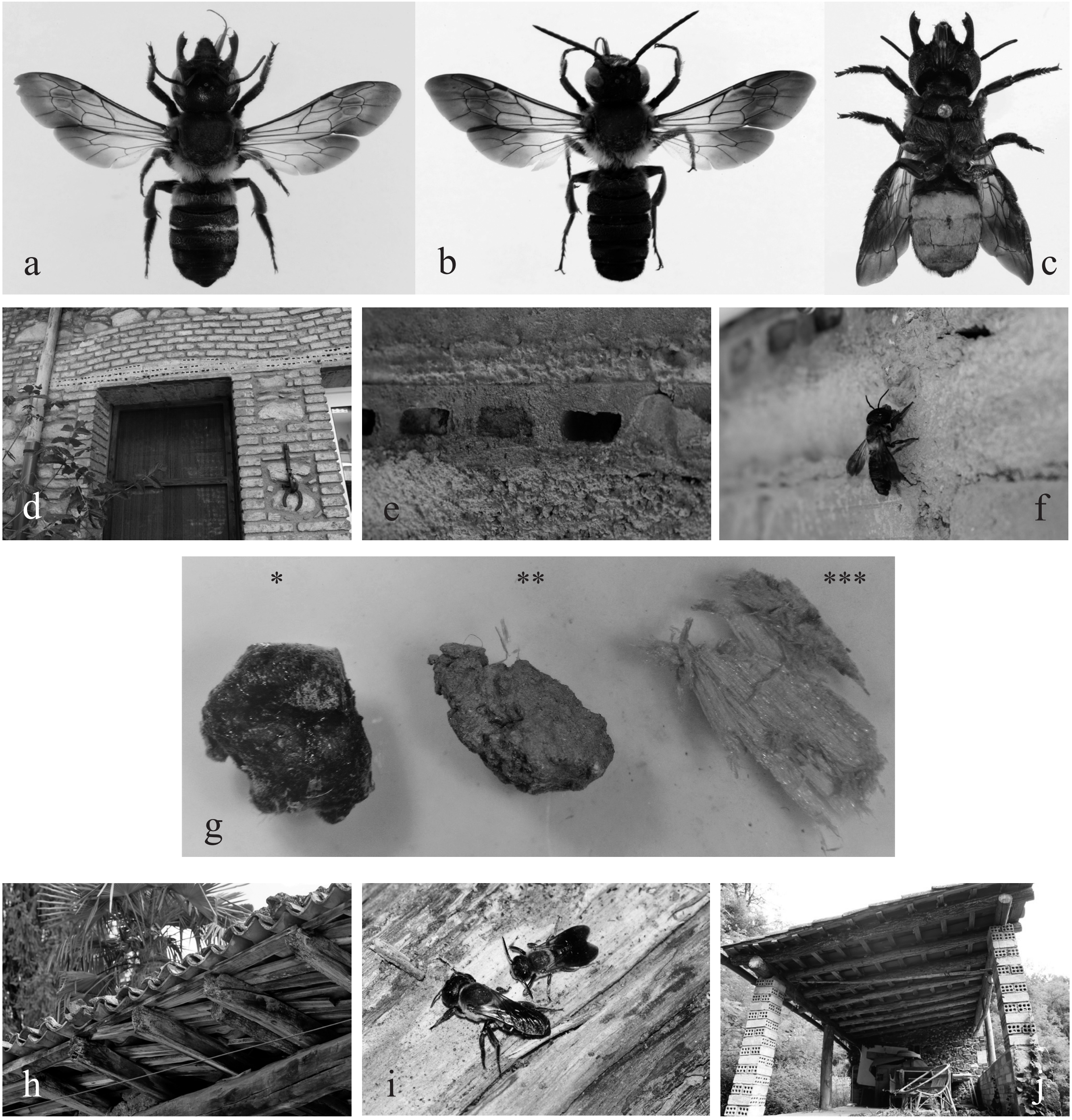

Figure 1. Pinned specimens of *Megachile sculpturalis* Smith, 1853: a) female; b) male; c) ventral view of a pinned female, with detail of the ventral scopae covered in pollen; d) nesting environment and resources used by *M. sculpturalis* at Site 1; e) idem in a private garden, 20 × 10 mm brick holes are closed using an extremely hard resin covered by a clay wall; f) female close to the nest entrance bearing resin (nesting material) in its mandibles; g) Nesting material transported by *M. sculpturalis*: (*) resin, (**) mud and (***) wood fibres; each material is ca. 5mm wide; h) nesting environment at Site 4. In a private garden, cavities in rotten wooden beams are used as nesting resources; i) habitus of *M. sculpturalis* female (left) and male (right) during observations of mating behaviour; j) Porch at Site 5, showing the rotten beams that were used for nesting. [Pictures by Oscar Aguado (a,b,c,h,i), Carlos Hernández-Castellano (d,e,f,g) and Emili Bassols (j)].

ence for *Styphnolobium japonica* (Westrich *et al.*, 2015; Le Féon *et al.*, 2017) and other exotic trees from its native range such as *Ligustrum* spp. (Quaranta *et al.*, 2014). However, other attractive native plants such as *Lavandula* spp. may also be used (Le Féon *et al.*, 2017).

Interestingly, Clinch *et al.* (1971) note that foraging on *Styphnolobium* spp. by native bees may lead to dramatic events of toxicity. Indeed, massive mortality of honeybees and bumblebees foraging on *S. japonica* trees in the towns of Sant Celoni –where some of our observations were made– and Girona have been recorded on several occasions. However, *M. sculpturalis* seems to be adapted to exploit this resource that is present in its native range. This is of importance because it suggests that an invader complex, i.e. a system of exotic species that facilitates the colonization and the expansion of each partner (Olesen *et al.*, 2002; Traveset & Richardson, 2006), is present in the study area. Thus, our observations –together with the reported negative effects it has on native bees– lead us to recommend that *Styphnolobium* sp. is not used as a garden tree in our region.

It has been demonstrated that *M. sculpturalis* competes with native bees with similar niche requirements, and even attacks the large carpenter bee *Xylocopa virginica* Linnaeus, 1771 and occupies its nests (Laport & Minckley, 2012; Roulston & Malfi, 2012). Because *M. sculpturalis* can nest only in pre-existing cavities about > 8 mm diameter (see Table 2), only a small subset of large solitary bees with similar nesting requirements are subject to potential competition with the exotic bee. Nest occupation and eviction of *Osmia* spp. have also been recorded (Le Féon *et al.*, 2017). Although we have no direct observations of competition with other species for nest sites, in Olot (Site 4) we observed a nesting female that was using an old *Xylocopa* sp. nest, while in Sant Celoni (Site 1) *M. sculpturalis* was seen to use the same nesting resources as used by the megachilid *A. florentinum*. Although this latter species is much smaller (14 mm long), this situation could lead to competition between these species if nesting resources become scarce.

Given that *M. sculpturalis* is found under a wide range of conditions (70–1540 m a.s.l.; Westrich *et al.* (2015)) and that Mediterranean ecosystems have highly diverse communities of solitary bees (Osorio *et al.* 2015, 2016), it is essential that the future expansion of *M. sculpturalis* throughout the Iberian Peninsula is monitored as a means of recording direct interaction with native bees and any impact that the presence of *M. sculpturalis* might have on native bee populations.

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