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A new species for the bee fauna of Italy: *Megachile sculpturalis* continues its colonization of Europe

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Abstract

During studies of bee diversity and nesting biology in the province of Verbania, Piedmont, northern Italy, a bee species recognized as foreign to the Italian fauna was observed. Observations were conducted on their life cycle and nesting behaviour, and specimens were collected for subsequent identification. The species in question was determined to be *Megachile* (*Callomegachile*) *sculpturalis* Smith (Hymenoptera Megachilidae), a species native to East Asia. The population has been present in the area since 2009 and the number of nests detected is expanding. The flight activity is from approximately 10 July to 15 August. We examine hypotheses that may explain the arrival of the insect. In addition, pollen samples were taken from the nests, preliminary results of pollen analysis are provided, and the potential impact of this invasive species on the local fauna and flora is examined.

Key words: Apoidea, alien species, giant resin bee, nesting behaviour, solitary bees, Megachilidae, Hymenoptera.

Introduction

The expansion of the distribution range of useful organisms such as pollinators is not generally considered a problem. Indeed, for a long time these invasions were thought not to cause competition with native pollinators and were considered a benefit to the local flora (Batra, 1998). However, in view of growing concern about the increasing reports of invasive species, today greater attention is being paid to the possibility that a new non-native pollinator species can compete with native ones and cause a decline in some of these or interfere with plant reproduction (Ornosa, 1995; Dafni and Shmida, 1996; McQuillan and Hingston, 1999; Goulson *et al*., 2003; Dupont *et al*., 2004; Aizen *et al.*, 2008; Stout and Morales, 2009; Dohzono and Yokoyama, 2010).

As part of a study initiated in 2009 concerning the life cycle and nesting behaviour of certain bee specimens that were unusually large for Italian fauna, specimens of both sexes were received by one of us (MQ) to be identified. These bees had nested in wooden railway sleepers in the territory of the parks and nature reserves of Ticino and Lake Maggiore.

In the following years, adults that had passed the winter were supplied with artificial nests of various types and observed during their flight and nesting activities. The specimens were found to belong to the species *Megachile* (*Callomegachile*) *sculpturalis* Smith (Hymenoptera Megachilidae), originally from Japan and countries on the South-East Asian coast. Since the 1990s this Megachilid species has become naturalized in North America (Mangum and Brook, 1997). Later, it starred in a fairly rapid expansion in North America (Hinojosa-Díaz *et al*., 2005; Hinojosa-Díaz, 2008; O'Brien and Craves, 2008) and has recently been reported for the first time in Europe (Vereecken and Barbier, 2009).

Notes on the biology of the species are found in Batra (1998). In addition to reporting a new species for the Italian bee fauna, this note is intended to provide a first contribution to the knowledge of the biological traits and behaviour of this species in the areas of new colonization in northern Italy.

Furthermore, since the species is likely to have been intercepted soon after its first entry into Europe and is easily recognized by its size, we propose a collaborative surveillance program on a continental level to monitor the spread.

Materials and methods

Identification

To verify specimen identification, the images, diagnostic keys, and detailed species descriptions of species of *Megachile* occurring in Canada, including the introduced *M. sculpturalis* (Sheffield *et al*., 2011), were used alongside the substantial collection of images of this species found in the scientific literature (Hinojosa-Díaz *et al*., 2005; Vereecken and Barbier, 2009) and on the internet (Ascher and Pickering, 2013).

Artificial nests

Two types of artificial trap-nests were used to induce this species to nest there. One consisted of a thuja (*Thuja* L.) tree trunk segment shaped to stand securely on a horizontal support (figure 1) and drilled with 31 holes. The second type was made by bundling a number of giant reeds stems (*Arundo donax* L.) with a diameter of no less than 1 cm (figure 2), as is used for other species of solitary bees (Krunic *et al*., 2005).

Figure 1. Thuja tree trunk used as a nest-trap (on left). In the trunk with a diameter of about 30 cm, 12-cm-long tunnels with 12-mm entry holes were drilled, forming a matrix with equidistant holes set 40 mm apart. Start of the flight, in July. Note at the base of the trunk some scraps of plugs that sealed the entrances of the nests since the previous year.
(In colour at www.bulletinofinsectology.org)

Figure 2. Giant reeds (*Arundo donax* L.) colonized by *M. sculpturalis*.
(In colour at www.bulletinofinsectology.org)

Figure 3. *M. sculpturalis* female inspecting a tunnel.
(In colour at www.bulletinofinsectology.org)

Preliminary observation on flight period and nesting activity

Teachers of the Verbania Istituto di Istruzione Superiore "Lorenzo Cobianchi" (Piedmont, Italy) conducted observations of bees' nesting activity in the artificial nesting blocks. The beginning and end of the active period were recorded, and pollen samples were later collected from a limited number of cells within the trap-nests and identified by morphological analysis, using reference slides and diagnostic keys. The observations were conducted in 2012 on 5, 12, 26, 27 July; 5, 13, 27 August; 15 September; 13 October; in 2013 on 9, 14, 19 July; 5, 6, 7, 8, 9, 10, 12, 13, 16 August.

Results

Specimen records

1 Male, 07 July 2009, Leg. A. Sommaruga and 1 Female, 31 July 2013, Leg. A. Sommaruga, Italy, Piedmont, Verbania, UTM 460729.75 E; 5087345.42 N. Both specimens are deposited in M. Quaranta's personal collection.

Nesting activity

In both years when observations were made, males started to fly around July 10, when the first adults broke the capsules that had sealed the entrance for the entire previous year, to exit from the nests. Over the next 10 days all the nests were opened by emerging bees. There were still no observations of any females engaged in foraging activity. The females' activity period started in both years around July 20 (figure 3). The activity consisted of females alternately bringing different materials to the same nest, i.e., pollen accumulated in the ventral scopa and, on the next trip, pellets of mud or resin carried between the mandibles. To close the nest, females first lay down the resin and then a covering of mud. The end date of the activity was likewise almost the same. In 2012 the nest entrances were all closed by August 13, and in 2013 by August 16. In 2013 there was an increase in the number of occupied holes compared with the previous year, because 25 stems of the giant reeds we placed near the trunk were also occupied (figure 2).

Females are able to nest in holes with a diameter varying between 10 and 20 mm, but when there is a choice they prefer those of 10-12 mm.

Provisioning

We analysed the pollen content of a brood cell to identify plants foraged.

The most abundant pollen was *Ligustrum* (81%) (Oleaceae), followed by *Castanea* (12%) (Fagaceae). Other pollen present in traces only (<1%) were *Astragalus/Ononis* f., *Robinia* (Leguminosae), Urticaceae/Moraceae, *Parthenocissus* (Vitaceae), *Eucalyptus* (Myrtaceae), *Rubus* f. (Rosaceae).

The light-coloured resinous material carried by females as pellets between their mandibles and added to the nest after many trips per day is very sticky and glutinous to the touch, but it immediately comes off the bees' mandibles, as if they had a non-stick coating.

Discussion

The first place this *Megachile* species was found in Europe was Allauch, a town not far from the port of Marseilles, France (Vereecken and Barbier, 2009). In addition to our finding, the insect was reported in the Canton of Ticino, southern Switzerland (Amiet, 2012). Shipping of infested timber is by far the most common way for wood-nesting insect species to travel and colonize other areas, and is probably the main method that promotes transcontinental jumps. Once these species reach a new area via shipping, the fastest way for them to spread to other areas is again via transportation routes, including train traffic and road transport. In the case of *M. sculpturalis*, the first detection in France occurred in 2008 and the first detection in Italy in 2009. This sequence does not necessarily show the actual order of arrival, but only the history of the discovery. These two locations are separated by the Alps, which suggests that the species is unlikely to have spread by natural means from France to Italy or vice versa, although the dispersal ability of large bees in general, such as bumblebees, seems surprising (Jenic *et al*., 2010; Quaranta and Felicioli, 2012; Cederberg *et al*., 2014). *M. sculpturalis* could have travelled between France and in Italy along one of two main roads connecting Marseilles with Turin, respectively 550 and 650 km long, which are covered daily by commercial traffic. However, in the present state of our investigations it is not possible to offer reliable hypotheses on the provenance of *M. sculpturalis.* It could have come by air or, more likely, by sea shipping. Apart from Marseilles, Genoa is another major port near the area of finding. The great tolerance of the species to woody substrate for nesting does not help. It may have been transported in propagation material or raw wood for furniture. In the area of Verbania there are both large sawmills and nurseries. Lastly, it may have been transferred inside pallets used to carry any type of commodity.

The species has become acclimatized at the site where it was first found in Italy and has increased the number of cavities colonized during the two years of observation. The start date of the flight period of *M. sculpturalis* coincides with that observed in North America, although it has been observed flying in the latter location until mid-September (Batra, 1998), while we have not observed its activities beyond mid-August.

Batra (1998) reports that the species had already been intercepted in commercial ports in North Carolina, USA, several times in the 1970s and 1980s, prior to its establishment in North America, and believes that a single fertilized female is enough to start a population in a new location. This is a real possibility for bees. Zayed *et al.* (2007) suggest the same thing happened for *Lasioglossum leucozonium* (Schrank) for North America and supported this with genetic data.

M. sculpturalis is largely polylectic and can feed on plants outside its native range (table 1). This factor helps exotic species successfully colonize areas far removed from the original ones.

The genus *Ligustrum* we found as the most abundant pollen in the preliminary analysis is also one of the giant resin bee's favourite plants in the United States (Batra, 1998; Mangum and Sumner, 2003; Hinojosa-Diaz *et al*., 2005; Laport and Minckley, 2012).

As is the case with other exotic bee species, it is expected that exotic ornamental plants would be preferred, especially those from the same region of origin (McNeely *et al*., 2001). It is possible that the insect increases the dispersal of exotic ornamental plants that have already proved to be preferred by *M. sculpturalis* and that occur in the newly colonized area in Italy, and it would be appropriate to monitor the spread of these plant species (table 1).

Since it has already been reported that *M. sculpturalis* may be competing for nesting sites with the carpenter bee *Xylocopa virginica* (L.) in eastern North America (Laport and Minckley, 2012; Roulston and Malfi, 2012), the question arises as to whether similar competition can occur with European species of *Xylocopa*. There are three species of *Xylocopa* that are widespread in Italy: *Xylocopa iris* (Christ), *Xylocopa valga* Gerstaecker, and *Xylocopa violacea* (L.), the latter being the most common. The entry holes of the nests of *X. virginica* have a diameter of 10 mm and average tunnel length is 17.5 cm (Gerling and Hermann, 1978). In Europe *X. violacea* was found breeding in cavities with a diameter of 12-16 mm (Dindo *et al*., 1992), *X. valga* in stems of 14 mm (Dindo *et al*., 1992) or 15-16 mm in diameter (Malyshev, 1931), and *X. iris* in stems of 6-10 mm in diameter (Grandi, 1961). Although we observed that *M. sculpturalis* prefers holes with a diameter of 10-12 mm, a range of 10-16 mm also might be suitable.

In the years to come, it would be sensible to monitor the local populations of three carpenter bees in Europe, *X. violacea*, *X. valga* and *X. iris*, in order to assess whether, with their nests, these three species could provide a tool for *M. sculpturalis* to spread in the area or to evaluate whether they can be displaced by *M. sculpturalis*. In this case, knowing the fate of the *Xylocopa* species is important in order to measure the effects in the relationship between *Xylocopa* species and plants foraged by them.

Although *M. sculpturalis* is an invasive species, as a pollinator species it is considered beneficial. Therefore, it will not be prevented from spreading, unlike other species harmful to human activities, such as *Vespa velutina* Lepeletier, recently collected in an area not far from the site of collection of *M. sculpturalis* (Demichelis *et al.*, 2013). Consequently, this finding opens interesting perspectives to study the changes that may be generated in mutualist webs through the introduction of invasive generalist species.

Recent studies (Aizen *et al*., 2008) suggest that when a generalist invasive alien species spreads into new areas, it can cause a decline in generalist native species while the overall stability of mutualistic networks simultaneously increases. Thus, the whole system of interactions of *M. sculpturalis* with other species of its network, such as foraged plants, competitors, enemies, and parasites, can be a model to test this theory and should continue to be monitored in the years to come. Furthermore, because of its considerable size, it hardly escapes notice. This would facilitate the collection and analysis of data by the general public, as part of a collaborative project with professional scientists.

Table 1. List of known plant species foraged by *M. sculpturalis*. Plant host data are reported from one or more studies as specified, along with their reported native range. Plant species occurring in the protected area or the study site in Italy are marked with an asterisk. Plant species names and their native range are according to The Plant List (2013), the USDA Germplasm Resources Information Network (GRIN, 2014) and the World Checklist of Selected Plant Families (WCSP, 2014). The native ranges are reported only for species.

Plant	Source	Native range
Apocynaceae		
Asclepias L. spp.	Mangum and Sumner, 2003	
Asclepias syriaca L.	Ascher, 2001	North America
Asteraceae		
**Cirsium vulgare* (Savi) Ten.	Ascher, 2001	Europe, Asia, North-west Africa
Bignoniaceae		
Catalpa speciosa (Warder) Engelm.	Batra, 1998; Mangum and Sumner, 2003	USA
Ericaceae		
Oxydendrum arboreum (L.) DC.	Batra, 1998; Mangum and Sumner, 2003	USA
Lamiaceae		
Perovskia artemisioides Boiss	Ascher, 2001	South Iran, Pakistan
Vitex L.	Mangum and Sumner, 2003	
Leguminosae		
Dunbaria villosa (Thunb. ex Murray) Makino	Batra, 1998	Myanmar, China, Cambodia, India, Indonesia, Japan, Korea, Laos, Philippines, Thailand, Vietnam.
Lathyrus latifolius L.	Ascher, 2001; Mangum and Sumner, 2003; Hinojosa-Diaz *et al*., 2005; O'Brien and Craves, 2008	North Africa, Europe
Lespedeza Michx. Spp.	Batra, 1998	
**Melilotus albus* Medik.	Ascher, 2001	North Africa, Asia, Europe
Millettia japonica A.Gray	Batra, 1998	Japan, Korea
Phaseolus vulgaris L.	Batra, 1998	North America, South America
**Pueraria lobata* (Willd.) Ohwi	Mangum and Brooks, 1997; Batra, 1998; Laport and Minckley, 2012	Russian Far East, China, Japan, Korea, Taiwan, Thailand, Vietnam, Indonesia, Malaysia, Papua New Guinea, Philippines, South-west Pacific
Securigera varia L. (Lassen) (=*Coronilla varia* L.)	Ascher, 2001	Africa, Western and Middle Asia, Europe
Styphnolobium japonicum (L.) Schott (= *Sophora japonica* L.)	Mangum and Sumner, 2003; Hinojosa-Diaz *et al*., 2005; Laport and Minckley, 2012	China
Vigna unguiculata (L.) Walp. (=*Vigna sinensis* (L.) Savi ex Hassk.)	Batra, 1998	Africa
Lythraceae		
Lagerstroemia indica L.	Batra, 1998	China, Taiwan, Cambodia, Laos, Thailand, Vietnam
**Lythrum salicaria* L.	Mangum and Sumner, 2003; O'Brien and Craves, 2008	North Africa, Asia, Europe
Oleaceae		
Ligustrum lucidum W.T.Aiton	Mangum and Sumner, 2003; Hinojosa-Diaz *et al*., 2005; Laport and Minckley, 2012	China
**Ligustrum vulgare* L.	Batra, 1998; Mangum and Sumner, 2003;	North Africa, Western Asia and Caucasus, Europe
Plantaginaceae		
Veronicastrum virginicum (L.) Farw.	O'Brien and Craves, 2008	North America
Rutaceae		
Citrus japonica Thunb. (=*Fortunella margarita* Swingle)	Batra, 1998	China, Japan, Taiwan
Sapindaceae		
Koelreuteria paniculata Laxm.	Mangum and Brooks, 1997; Batra, 1998; Mangum and Sumner, 2003; Hinojosa-Diaz *et al*., 2005; Laport and Minckley, 2012	China
Scrophulariaceae		
**Buddleja davidii* Franch	Mangum and Sumner, 2003	China
**Verbascum thapsus* L.	Ascher, 2001	Asia, Europe

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Credits: MQ and AF devised the observation protocols and saw the entire work through to publication, they also developed data collection protocols; MQ identified the specimens. Both have been responsible for planning and writing the paper. AS and PB collected data, made nesting sites, and coordinated the data collection performed by the students of I.I.S. "L. Cobianchi". Both contributed substantially to the drafting of the final text.

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