УДК 595.799:591.5(292.471)

Giant resin bee *Megachile* (*Callomegachile*) *sculpturalis* Smith, 1853 (Hymenoptera, Apoidea, Megachilidae), an invasive species in the Crimea (notes on its biology)[1]

Ivanov S. P. [1]***, Fateryga A. V.*** [2]***, Zhidkov V. Yu.*** [1]***, Pivovarenko N. A.*** [3]

[1] *Taurida Academy of the V. I. Vernadsky Crimean Federal University*
Simferopol, Republic of Crimea, Russia
spi2006@list.ru, aravar@list.ru
[2] *T. I. Vyazemsky Karadag Scientific Station – Nature Reserve of RAS – Branch of A. O. Kovalevsky Institute of Biology of the Southern Seas of RAS*
Feodosia, Republic of Crimea, Russia
fater_84@list.ru
[3] *Junior Academy of Science of the Crimea "Iskatel"*
Simferopol, Republic of Crimea, Russia
pivovarenkodkb@mail.ru

A new invasive bee species, *Megachile sculpturalis* Smith, 1853 was revealed nesting in Simferopol (Crimea) in 2019. Bees occupied a "bee hotel" located on the 5th floor of a building on the outskirts of the town. These bees were transferred to one and two new localities in 2020 and 2021, respectively. A total of 86 nesting females were found in these three localities in 2021. Females built their nests in paper tubes and reed canes. One nest contained from 1 to 12 cells constructed of conifer resin with the addition of mud and sawdust. The females visited flowers of five different plant species; though, they brought only pollen and nectar taken from *Styphnolobium japonicum* (L.) Schott to their nests.

Key words: giant resin bee, nesting, "bee hotel", *Styphnolobium japonicum*.

INTRODUCTION

The native range of the giant resin bee *Megachile* (*Callomegachile*) *sculpturalis* Smith, 1853 includes China, Korea, and Japan. In 1994, this species was accidentally observed in North America in the state of North Carolina (Mangum, Brooks, 1997), and then it was successively recorded in a number of other states. At present, it is spread widely across the United States, reaching Minnesota in the north, Maine in the northwest, Texas in the southwest, and Florida in the southeast, and also penetrated into Canada (Mangum, Brooks, 1997; Hinojosa-Díaz, 2008; Parys et al., 2015; Bila Dubaić, Lanner, 2021, etc.). In 2002, the species was first found in India (Sardar et al., 2021). In Europe, *M. sculpturalis* was first detected in 2008 in France (Vereecken, Barbier, 2009), and then it was recorded in 2010 in Italy (Quaranta et al., 2014) and Switzerland (Amiet, 2012). Further records of *M. sculpturalis* were made in 2015 in Germany (Westrich et al., 2015) and Hungary (Kovács, 2015), in 2016–2017 in Slovenia and Austria (Gogala, Zadravec, 2018), and in 2018 in Spain (Aguado et al., 2018) and the Crimea (Ivanov, Fateryga, 2019). Currently, the extreme points of distribution of the species in Europe are the central regions of Germany in the north, the Crimean Peninsula in the east, the island of Mallorca in the south, and the Occitania region (France) in the west (Bila Dubaić, Lanner, 2021).

The bee *M. sculpturalis* is one of the largest species of megachilid bees. Females can reach a body length of more than 25 mm, which is about twice the size of a honey bee. The head and the metasoma are covered with sparse black setae, while the mesosoma is covered with dense bright brick pubescence (Figs 1 and 2 *a*, *b*).

[1] This article was originally published in Russian as a conference paper in *Sovremennyye dostizheniya v oblasti apidologii [Modern achievements in the field of apidology]: collection of articles of the 1st International Scientific and Practical Conference (Ufa, 24 June, 2021). Ufa: M. Akmulla Bashkir State Pedagogical University, 2021, pp. 16–23* and translated by the authors.

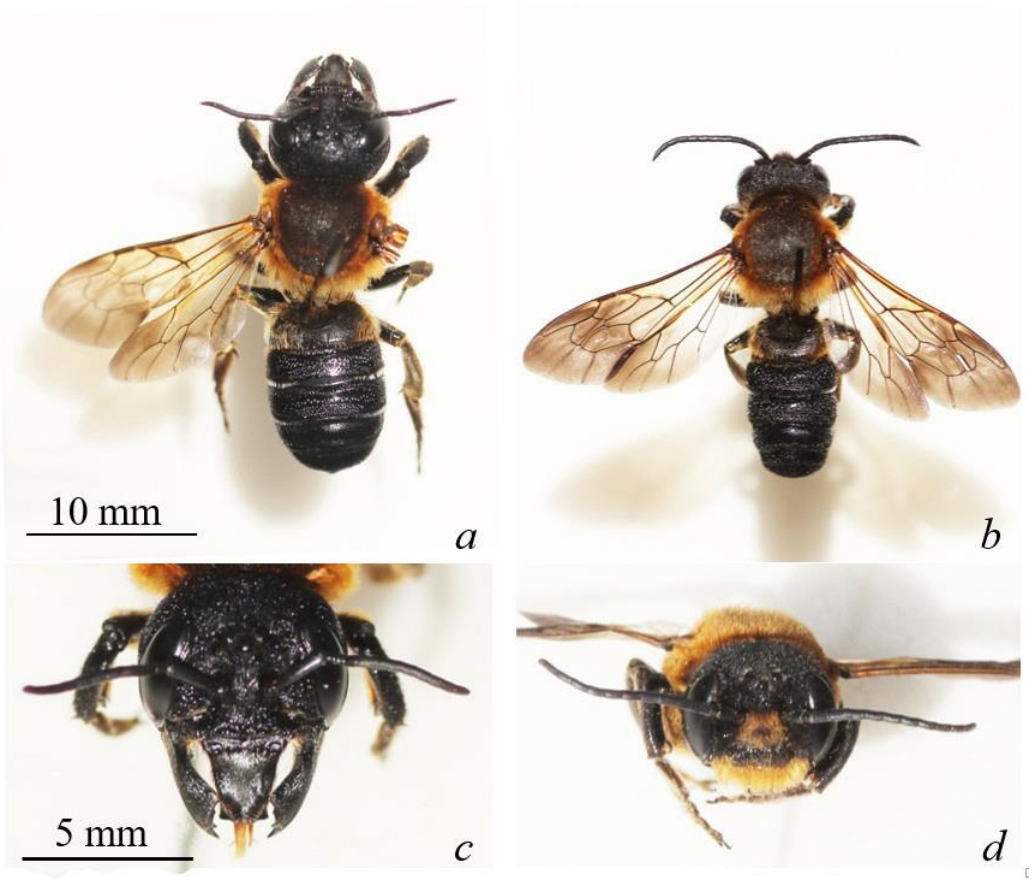

Fig. 1. The giant resin bee *Megachile sculpturalis*: female (*a*), male (*b*), female head (*c*), male head (*d*)

In addition to its large size and typical color pattern, *M. sculpturalis* differs from other (native) megachilid bees by relatively long mandibles (both in females and males) and characteristic pubescence of the facial part of the head in males: the setae on the edge of the clypeus form a yellowish band resembling a smile or mustache (Fig. 1 *d*).

The bee *M. sculpturalis* uses various cavities for nest construction, preferring abandoned nests of carpenter bees (Hymenoptera: Apidae: *Xylocopa*). Apparently, this feature contributed to disperse of *M. sculpturalis* to other continents along with timber. North Carolina, the site of the first discovery of the species in America, is known for mass production of wooden furniture. It is assumed that this species has expanded its native range using maritime trade routes (Le Féon et al., 2018). *Megachile sculpturalis* builds cells of its nests mainly of resin (therefore, the species was named "giant resin bee"). It also uses mud and sawdust for sealing the cells (Hinojosa-Díaz et al., 2005; Quaranta et al., 2014; Westrich et al., 2015).

The bee *M. sculpturalis* was recorded at more than 25 species of forage plants (Quaranta et al., 2014, etc.); however, three species were confirmed to be the main pollen sources in Europe: *Ligustrum* sp. (Oleaceae) and *Castanea* sp. (Fagaceae) in Italy (Quaranta et al., 2014) and *Styphnolobium japonicum* (L.) Schott (Fabaceae) in Germany (Westrich et al., 2015). Researchers also highlight that the studied species prefers flowers of *Lavandula* spp. (Lamiaceae) and *Wisteria* spp. (Fabaceae) (Guariento et al., 2019; Ruzzier et al., 2020).

MATERIAL AND METHODS

The first nest of *M. sculpturalis* was found in a trap nest in September 2018 on the southern outskirts of Simferopol. The nest was built in a reed cane of *Phragmites australis* (Cav.) Trin. ex Steud. (Poaceae) and it contained a single cell with a prepupa, the development of which ended in

death the following year. However, in early September 2019, the first nesting females of *M. sculpturalis* were found in Simferopol. There were seven females finishing the nesting season in a "bee hotel" located on an inset balcony on the fifth floor of a building of the Taurida Academy of the V. I. Vernadsky Crimean Federal University (Fig. 2 *c*).

Fig. 2. Bees *Megachile sculpturalis* and constructions in which bees of this species nested
a – a female on an inflorescence of *Carduus acanthoides* L.; *b* – a male waiting for a female to emerge from the mother nest; *c* – a part of the "bee hotel" where the nesting females were observed for the first time in 2019; *d* – experimental Fabre's hive inhabited by bees in 2020 and 2021.

The building was also located on the southern outskirts of Simferopol and was surrounded by single-storey residential buildings in the private sector with plots of land. Different species of angiosperm and coniferous trees including several trees of *Styphnolobium japonicum* grew on the territory of the university campus. Moreover, the botanical garden of the Crimean Federal University with a variety of vegetation was located in the immediate vicinity of the university building. The "bee hotel" (Fig. 2 *c*) was made up of bundles of segments of reed canes and twisted paper tubes.

The "bee hotel" was situated there since 1988. Initially, nests of several bee species were placed into the "hotel". These nests were obtained from trap nests located all over Crimea (Ivanov et al., 2019). Some species of bees being placed into the "hotel" inhabited it and continued to nest there in subsequent years: *Osmia bicornis* (Linnaeus, 1758), *O. cornuta* (Latreille, 1805), *O. bidentata* Morawitz, 1876, *Hoplitis manicata* Morice, 1901, and *Heriades crenulata* Nylander, 1856. Nesting of other bee species was sporadic, for instance, *Hylaeus* spp., *Osmia caerulescens* (Linnaeus, 1758), *Megachile rotundata* (Fabricius, 1787), *M. maritima* (Kirby, 1802), *Anthidium manicatum* (Linnaeus, 1758), and *Xylocopa valga* Gerstäcker, 1872 (Ivanov et al., 2017). Taking into consideration that *M. sculpturalis* has a tendency to nest in the nests of carpenter bees (*Xylocopa* spp.), it can be assumed that a large number of open nests provisioned by female bees *H. manicata*, *O. bidentata*, and *H. crenulata* was one of the cues attracting *M. sculpturalis* to a "hotel" in the first half of July (the period when resin bees search for a nesting site).

In 2020 and 2021, *M. sculpturalis* bees were transferred to one and two new localities, respectively, by planting mother nests in Fabre's hives. Fabre's hives (Fig. 2 *d*) were made from a cardboard boxes filled with segments of hollow reed canes.

The trophic preferences of bees were studied during the examination of pollen taken from the metasomal scopa of bees arriving to the hive with pollen and nectar (Ivanov, Menzatova, 2016).

RESULTS AND DISCUSSION

In 2021, the total number of nesting females of *M. sculpturalis* in three localities was 86; i. e., every season there was an increase in the number of females in individual hives by two to three times.

In 2021, we observed emergence of bees from 34 mother nests located in one of the hives. Emergence from the nests began on July 6 and lasted until July 23. During the first five days, only males emerged; the first females began to emerge from the sixth day. After leaving the mother nests male progeny were constantly seen near the hives, patrolling the reed canes and being involved in fights chasing each other. The characteristic features of male behavior of this species were approaching each other in flight, hovering in the air and further joint getting high in the air in a "face to face" position. As a rule, at a height of 3–4 meters, one of the males gave way to the competitor and retreated. When females began to emerge from their nests, the behavior of males changed. One of them (usually the largest) occupied a position directly at the exit from the nest (Fig. 2 *b*) and did not leave this place until the female emerged from the nest. When other males approached him, he began to vibrate his wings actively, and this was enough for competitors to fly away. Not a single female (out of 16 tracked) managed to leave the nest and fly away alone from the hive. The male waiting for her courted her, the pair fell to the ground in front of the hive and, despite the attacks of other males, it usually managed to copulate successfully.

On the same day after the emergence from the mother nest, the females returned to the hive and stood for the night in the mother nest. Females demonstrated exceptional attraction to the nest, arranging a struggle for settlement. Some of the females, who did not find suitable cavities near the mother nest, examined the nearest space. If there were several empty hives, the females chose one of them, tending to nest jointly.

When females nested in Fabre's hives, they chose cavities in a wide range of diameters: from 6 to 12 mm, showing no particular preference for cavities of any certain diameter. There was also no preference for cavities made of any certain material: reed canes, paper tubes, or borings drilled in wood.

At the same time, females occupied all empty nests of carpenter bees in several pieces of wood located next to the hives.

Fig. 3. Structure of *Megachile sculpturalis* nests

a – a nest consisting of five cells built in a paper tube; arrows show the layers of partitions between the cells made of mud; *b*, *c* – one-cell and five-cell nests built in segments of reed canes; *d* – a blockage of loose debris in a vestibule; *e*, *f* – nest cells containing eggs and larvae of different ages.

The dissection of 27 fully constructed and sealed nests showed that the number of cells in them could vary from 1 to 12. Partitions can be made of pure resin or consist of several layers – one layer of resin, a layer of mud and the second layer of resin (Fig. 3*a*). In this case, the partition closing the last cell consisted, as a rule, of only two layers: resin and mud.

A continuous row of cells in the nest started from the bottom of the cavity and ended with an empty space, so-called nest vestibule. The end of the vestibule closest to the exit was filled with

pieces of various materials, which were not fastened together in any way and formed a kind of blockage. In Fig. 3 *b*, the blockage is shifted to the last cell. This shift, apparently, occurred during the dissection of the cane. Bees collected material for the blockage around the hive or in the reed canes of the hive itself. These could be sawdust, lumps of soil, pebbles, fallen and dried flowers, and even dry corpses of insects. The closing mud plug of the nest was the heaviest and the thickest, its surface was extremely uneven from the side of the vestibule, though it was even and carefully smoothened from the outside.

The pollen loaf, as a rule, filled half the volume of the cell. It had thick consistency, it held its shape well, its surface, facing the empty space of the cell, was almost flat or slightly concave. The egg with the posterior end was slightly immersed in the mass of the pollen loaf and tilted relative to its surface at an angle close to 45° (Fig. 3 *e*). During feeding, larvae occupied the position in the cell shown in Fig. 3 *f*.

Observations on *M. sculpturalis* females at flowers at the hive sites proved that they visited at least five plant species: *Ballota nigra* L. (Lamiaceae), *Carduus acanthoides* L., *Inula helenium* L. (both Asteraceae), *Eryngium campestre* L. (Apiaceae), and *Styphnolobium japonicum*; however, microscopic examination of pollen taken from the metasomal scopa of 27 females during the period of active provisioning showed the presence of pollen of only one species, *S. japonicum* (it was previously identified incorrectly as *B. nigra* by Ivanov, Fateryga, 2019).

CONCLUSION

Our studies emphasize that *M. sculpturalis* possesses a number of peculiar morphological and ethological features not typical of the native species. Further studies of *M. sculpturalis* in the Crimea can be devoted to the study of its trophic relationships, foraging activity, and some aspects of nesting behavior, mechanisms of regulating the sex ratio in the progeny, and the relationships between females in aggregation settling in Fabre's hives. Apparently, the eastward dispersal of this species will continue.

The work of A. V. Fateryga was a part of the State research project No. 121032300023-7 of the A. O. Kovalevsky Institute of Biology of the Southern Seas of RAS.

References

Aguado O., Hernández-Castellano C., Bassols E., Miralles M., Navarro D., Stefanescu C., Vicens N. *Megachile* (*Callomegachile*) *sculpturalis* Smith, 1853 (Apoidea: Megachilidae): a new exotic species in the Iberian Peninsula, and some notes about its biology // Butlletí de la Institució Catalana d'Història Natural. – 2018. – Vol. 82. – P. 157–162.

Amiet F. Die Blattschneiderbiene *Megachile sculpturalis* Smith, 1853 (Hymenoptera: Apidae) nun auch in der Schweiz // Entomo Helvetica. – 2012. – Bd. 5. – P. 157–159.

Bila Dubaić J., Lanner J. *Megachile sculpturalis* (Hymenoptera: Megachilidae): a valuable study organism for invasive pollinators and the role of beekeepers in ongoing monitoring programs // Bee World. – 2021. – Vol. 98, N 3. – P. 78–82. – https://doi.org/10.1080/0005772X.2021.1940580

Gogala A., Zadravec B. First record of *Megachile sculpturalis* Smith in Slovenia (Hymenoptera: Megachilidae) // Acta Entomologica Slovenica. – 2018. – Vol. 26, N 1. – P. 79–81.

Guariento E., Lanner J., Staggl M. A., Kranebitter P. *Megachile sculpturalis* (Smith, 1853) (Hymenoptera: Megachilidae), the giant resin bee new to South Tyrol with a newly described plant species interaction // Gredleriana. – 2019. – Vol. 19. – P. 209–215. – https://doi.org/10.5281/zenodo.3565365

Hinojosa-Díaz I. A. The giant resin bee making its way west: first record in Kansas (Hymenoptera: Megachilidae) // ZooKeys. – 2008. – Vol. 1. – P. 67–71. – https://doi.org/10.3897/zookeys.1.17

Hinojosa-Díaz I. A., Yáñez-Ordóñez O., Chen G., Peterson A. T., Engel M. S. The North American invasion of the giant resin bee (Hymenoptera: Megachilidae) // Journal of Hymenoptera Research. – 2005. – Vol. 14, N 1. – P. 69–77.

Ivanov S. P., Fateryga A. V. First record of the invasive giant resin bee *Megachile* (*Callomegachile*) *sculpturalis* Smith, 1853 (Hymenoptera: Megachilidae) in the Crimea // Far Eastern Entomologist. – 2019. – N 395. – P. 7–13. – https://doi.org/10.25221/fee.395.2

Ivanov S. P., Fateryga A. V., Zhidkov V. Yu. Aculeate Hymenoptera (Hymenoptera, Aculeata) inhabiting trap nests in Crimea // Entomological Review. – 2019. – Vol. 99, N 2. – P. 163–179. – https://doi.org/10.1134/S0013873819020040

Ivanov S. P., Menzatova E. A. Method of study of megachilid wild bees trophic relations (Hymenoptera, Megachilidae) based on the analysis of the pollen composition from nest cells and scopa of females // Ekosistemy. – 2016. – Iss. 5. – P. 66–86. [In Russian]

Ivanov S. P., Yanenko B. V., Menzatova E. A. Comparative study of nesting biology of four wild bees species (Hymenoptera, Megachilidae) in the composition of artificial aggregation // Ekosistemy. – 2017. – Iss. 12. – P. 35–44. [In Russian]

Kovács T. *Megachile sculpturalis* Smith, 1853 in Hungary (Hymenoptera, Megachilidae) // Folia Historico-Naturalia Musei Matraensis. – 2015. – Vol. 39. – P. 73–76.

Le Féon V., Aubert M., Genoud D., Andrieu-Ponel V., Westrich P., Geslin B. Range expansion of the Asian native giant resin bee *Megachile sculpturalis* (Hymenoptera, Apoidea, Megachilidae) in France // Ecology and Evolution. – 2018. – Vol. 8, N 3. – P. 1534–1542. – https://doi.org/10.1002/ece3.3758

Mangum W. A., Brooks R. W. First records of *Megachile* (*Callomegachile*) *sculpturalis* Smith (Hymenoptera: Megachilidae) in the Continental United States // Journal of the Kansas Entomological Society. – 1997. – Vol. 70, N 2. – P. 140–142.

Parys K., Tripodi A., Sampson B. The giant resin bee, *Megachile sculpturalis* Smith: new distributional records for the mid- and gulf-south USA // Biodiversity Data Journal. – 2015. – Vol. 3. – Article e6733. – https://doi.org/10.3897/BDJ.3.e6733

Quaranta M., Sommaruga A., Balzarini P., Felicioli A. A new species for the bee fauna of Italy: *Megachile sculpturalis* continues its colonization of Europe // Bulletin of Insectology. – 2014. – Vol. 67, N 2. – P. 287–293.

Ruzzier E., Menchetti M., Bortolotti L., Selis M., Monterastelli E., Forbicioni L. Updated distribution of the invasive *Megachile sculpturalis* (Hymenoptera: Megachilidae) in Italy and its first record on a Mediterranean island // Biodiversity Data Journal. – 2020. – Vol. 8. – Article e57783. – https://doi.org/10.3897/BDJ.8.e57783

Sardar S., Rameshkumar A., Kazmi S. I. First report of *Megachile* (*Callomegachile*) *sculpturalis* Smith, 1853 (Apoidea: Megachilidae) from India // Journal of Insect Biodiversity. – 2021. – Vol. 23, N 2. – P. 43–49. – https://doi.org/10.12976/jib/2021.23.2.2

Vereecken N. J., Barbier E. Premières données sur la présence de l'abeille asiatique *Megachile* (*Callomegachile*) *sculpturalis* Smith (Hymenoptera, Megachilidae) en Europe // Osmia. – 2009. – N 3. – P. 4–6.

Westrich P., Knapp A., Berney I. *Megachile sculpturalis* Smith 1853 (Hymenoptera, Apidae), a new species for the bee fauna of Germany, now north of the Alps // Eucera. – 2015. – N 9. – P. 3–10.

Иванов С. П., Фатерыга А. В., Жидков В. Ю., Пивоваренко Н. А. Гигантская смоляная пчела *Megachile* (*Callomegachile*) *sculpturalis* Smith, 1853 (Hymenoptera, Apoidea, Megachilidae) – инвазивный вид в Крыму (заметки о биологии) // Экосистемы. 2021. Вып. 58. С. 122–128.

Новый инвазивный вид пчел *Megachile sculpturalis* Smith, 1853 был обнаружен на гнездовании в Симферополе (Крым) в 2019 г. Пчелы, в количестве не менее 7 самок, заселили «гостиницу для пчел», расположенный на пятом этаже здания на окраине города. В 2020 и 2021 гг. самки вместе с материнскими гнездами были переселены в ульи Фабра, которые были установлены в двух новых пунктах Симферополя. Всего в трех пунктах Симферополя в 2021 г. было зарегистрировано 86 гнездящихся самок. Число гнездящихся в ульях самок каждый следующий год увеличивалось в 2–3 раза. Самки устраивали гнезда в трубках из бумаги и в тростниковых стеблях. Одно гнездо могло содержать от 1 до 12 ячеек. Ячейки были построены из смолы хвойных деревьев с добавлением опилок и замазки из влажной земли. Самки посещали цветки пяти разных видов растений; однако они приносили в свои гнезда только пыльцу и нектар, взятые с цветков *Styphnolobium japonicum* (L.) Schott.

Ключевые слова: гигантская смоляная пчела, гнездование, «гостиница для пчел», *Styphnolobium japonicum*.

Received 15.11.21
Accepted 15.12.21