Ivanov S.P., Gaul A.M.A.

The Value of the Fabre's Hives Front Wall Construction for Wild Bees *Osmia cornuta* (Latr.) (Apoidea, Megachilidae)

*Crimean Federal University named after Vernadsky
(Russia, Simferopol)*

doi 10.18411/gq-30-03-2019-25

idsp sciencerussia-30-03-2019-25

The wild bees of the Megachilidae family are distinguished by an exceptional variety of nest structures and building materials used by them (Radchenko, Pesenko, 1994; Michener, 2007, Ivanov, 2010). A number of Megachilidae species populate readily artificial nesting structures —Fabre's hives (Malyshev, 1963), and thus they can be used in artificial breeding and pollination of difficult-to-polish crops. At present, the technology of artificial breeding of wild bees, including *Osmia* bees, is developed for several species. Most species of *Osmia* bees are bred for pollination of fruit trees: *Osmia lignaria* in the USA (Levin, 1957; Boschetal., 2006); *O. cornifrons* and *O. pedicornis* in Japan (Hirashima, 1963; Maeta, 1990); *O. bicornis* in Europe (Free, Williams, 1970); *O. jacoti* and *O. excavata* in China (Zhouet. al., 1992).

In a number of studies, an attempt to identify the optimal design of hives suitable for breeding certain species of wild bees (Takiet. Al., 2008; Martinset. Al., 2012, and others) was made. As a result of these and other studies, several hive designs were developed and patented for wild bees breeding (Olifir, 1990; Ivanov, 1996; Ivanov, Zhidkov, 2017). Improvement of existing Fabre's hives design and development of new ones is an urgent and practically important task.

The purpose of our research is to identify the influence of a special construction in the form of blinds, fixed on the front side of the Fabre's hives, on the attractiveness of such hives for females of wild bees *Osmia cornuta* (Latreille, 1805) (Fig. 1, a-b).

In our experiments, the Fabre's hives were used in the form of boxes filled with pieces of hollow reed stems (*Phragmites australis* (Cav.) Trin. ExSteud) used by the female bees to build nests. The front side of the experimental hives was framed with blinds plates inserted into the frame (Fig. 1c –e, table. 1).

a

b

Fig. 1. The *Osmia cornuta* females collecting pollen and nectar on fodder plants (a, b), and three experimental Fabre's hives (c, d, e) equipped with the blinds nozzle with different inclination of the plates

In the experiments, the hives with four variants of blinds plates' orientation were used (Table 1). In one of the experiments, the colonization of the hives of the first variant was compared with the second one, in the second experiment – the third variant was compared with the fourth one. And in each of the variants of the hives design, the upper third of the front side of the hive was compared with the lower one, and the side part of the hive at the edge of the hive front side was compared with the central one.

In the first two variants, the blinds plates were located at an angle of 45° relative to the plane of the front side of the hive. In this case, in the first variant, the plates were tilted down, and in the second one, they were raised up. In both of these variants, the plates were placed horizontally.

Table 1
The results of hives colonization equipped with blinds by the *Osmia cornuta* females

Variant #	Placement of blinds plates	Area of the hive's front side	Quantity of nests
1		Upper third of the hive's front side	61
		Lower third of the hive's front side	79 (> for 29 %)
		Side part of the hive at the edge of the front side	78(> for 89 %)
		Central part of the hive's front side	42
	The total percentage of colonization of this variant, including middle sections, %		44.0
2		Upper third of the hive's front side	25 (> for 25 %)
		Lower third of the hive's front side	20
		Side part of the hive at the edge of the front side	29 (> for 81 %)
		Central part of the hive's front side	16
	The total percentage of colonization of this variant, including middle sections, %		17.0

3		Upper third of the hive's front side	58(> for 87 %)
		Lower third of the hive's front side	31
		Side part of the hive at the edge of the front side	52(> for 10 %)
		Central part of the hive's front side	47
	The total percentage of colonization of this variant, including middle sections, %		17.8
4		Upper third of the hive's front side	44(> for 13 %)
		Lower third of the hive's front side	39
		Side part of the hive at the edge of the front side	48(> for 12 %)
		Central part of the hive's front side	43
	The total percentage of colonization of this variant, including middle sections, %		20.0

The experimental hives differed in orientation of the plates in space. Female *O. cornuta* bees were introduced into hives with maternal nests.

In the third and fourth variants, the plates were located perpendicular to the plane of the front side of the hive, while in the first case (third variant), the plates were placed vertically, and in the other case (fourth variant) – horizontally.

The colonization results of all variants of hives, the front side of which was covered with blinds, are presented in Table 1. The certainty of differences between the compared parts of the hive in all cases, for which the difference in colonization density was more than 25%, is equal to or more than 99% of probability. The difference less than 25% is certain with (95% probability).

From the table it follows that the *O. cornuta* bees showed clear preference for only one of the variants presented in the first pair of the hives – 44.0% compared with 17.0. In the second pair of variants, they showed slight preference for the hives of the fourth variant compared to the third one: 20.0% versus 17.8.

At the same time, significant differences were revealed in the colonization of individual areas (parts) of the front side of the hives. In particular, for all the hive variants, the preferred colonization of the side part of the hives at the edge of their front side was revealed, and the most pronounced colonization was revealed in the first two variants with inclined blinds.

The preference for colonization of the upper or lower part of the front side of the hives was noted in all versions of the hives, but in different ways – in three cases the bees preferred the upper part of the hive (2, 3 and 4 variants), and in two cases they preferred the lower one (1 variant). The greatest preference was noted for the hive with vertical plates mounted perpendicular to the plane of the front side of the hive plane.

Thus, we can conclude that the installation of blinds on the front side of the Fabre's hives has a significant impact on the choice of females for laying nests within the area of the front side of the hive. Also, the orientation of the plates relative to the horizon (vertical or horizontal), and their orientation relative to the plane of the front side of the hive (the plates are raised up or tilted down) make the difference.

If we assume that the population of hives by females of wild bees is determined by two factors, namely, the intention of females to choose a nesting canal, which is located most secretly, and their ability to orient within the front side of the hive where the inlets of the

nesting tubes are located (Ivanov et al., 2014), the *O. cornuta* bees should be attributed to species with relatively weak orientation ability. It is proved by the pronounced uneven population of nesting tubes within the front side of the hives. This circumstance indicates the prospects of further work on the development of the hive design most suitable for breeding this species of bees.

1. Ivanov S. P. Patent for the invention of the Russian Federation 2067826. Device for regulating the population of the hive by wild bees; 6 A 01 K 47/00 / S. P. Ivanov. – No. 92004807/15; Appl. 4.11.92; Publ. 10/20/96, Bul. № 29. – P. 3.
2. Ivanov S. P. Materials for the comparative study of the structure of the leaf-cutting bees nests (Hymenoptera, Megachilidae, Megachile Latr.). Report I. The variety of nesting structures // Academic Records of the Taurida National University named after V. I. Vernadsky. Series “Biology, Chemistry”. – Simferopol: TNU, 2010. – Vol. 23 (62), No. 3. – P. 68–78.
3. Ivanov S. P., Zhidkov V. Yu. Patent for the invention of the Russian Federation No 186009, MPK: A01K 47/00. Hive for wild bees / Ivanov S. P., Zhidkov V. Yu patent holder Federal State Autonomous Educational Institution of Higher Education Crimean Federal University named after V. I. Vernadsky. – Request No. 201714710; Appl. 29.12.2017, Publ. 26/12/18, Bul. No. 36. – P. 3.
4. Ivanov S. P., Zhidkov V. Yu., Dubinina A. V. Study of the orientation ability of Megachilidae bees (Hymenoptera: Megachilidae) according to the results of their colonization of trap nests // Eurasian Union of Scientists. Monthly scientific journal. – 2014. – No. 9, part 3. – P. 44–46.
5. Malyshev S. I. Wild pollinators in the service of man. – M. – L.: Science, 1963. – P. 63.
6. Olifir V. N. Copyright certificate of the Russian Federation 1535499. Nest for wild bees; 5 A 01 K 47/00 V. N. Olifir. No. 4410801 / 30–15; Appl. 22.02.88. Publ. 15.01.90, Byul. No. 2. – P. 3.
7. Radchenko V. G., Pesenko Yu. A. Biology of bees (Hymenoptera, Apoidea). – SPb: Zoological Institute of RAS, 1994. – P. 350.
8. Bosch J., Kemp W. P., Trostle G. E. Bee population returns and cherry yields in an orchard pollinated with *Osmia lignaria* (Hymenoptera: Megachilidae) // J. economic Entomol. – 2006. – Vol. 99, No. 2. – P. 408–413.
9. Free J. B., Williams I. H. Preliminary investigations on the occupation of artificial nests by *Osmia rufa* L. (Hymenoptera, Megachilidae) // J. appl. Ecol. – 1970. – Vol. 7, No. 3. – P. 559–566.
10. Hirashima Y. Notes on the utilization of *Osmia cornifrons* as a pollinator of apples // Kontyū. – 1963. – Vol. 31. – P. 280. Free J. B., Williams I. H. Preliminary investigations on the occupation of artificial nests by *Osmia rufa* L. (Hymenoptera, Megachilidae) // J. appl. Ecol. – 1970. – Vol. 7, N 3. – P. 559–566.
11. Maeta Y., Kitamura T. Some biological notes on the introduced wild bee, *Osmia* (*Osmia*) *lignaria* Say (Hymenoptera, Megachilidae) // Bull. Tohoku natur.Agron.Exper.Station. – 1968. – 36. – P. 53–70.
12. Martins C. F., Ferreira R. P., Carneiro L. T. Influence of the Orientation of Nest Entrance, Shading, and Substrate on Sampling Trap-Nesting Bees and Wasps // Neotropical Entomology. – 2012. – Vol. 41, Is. 3. – P. 105–111.
13. Michener C. D. The bees of the world, second edition. Johns Hopkins University Press, Baltimore, London, 2007. – 953 pp.
14. Taki H., Kevan P. G., Viana B. F., Silva F. O., Buck M. Artificial covering on trap nests improves the colonization of trap-nesting wasps // J. Appl. Entomol. – 2008. – 132 – P. 225–229.
15. Zhou W.-R., Wang R., Wei S.-G. Utilization of *Osmia* bees as pollinators for fruit trees in China // Proc. 19th Intern. Congr. Entomol (Abstracts). – Beijing, 1992. – P. 249.