

ASPECTS OF HYMENOPTERA ENTOMOPHAGES ATTRACTION FOR BIOLOGICAL PLANT PROTECTION OF THE AGROCENOSIS

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KEYWORDS	ABSTRACT
Entomophages Pollinators Field breeding Artificial shelters <i>Hymenoptera</i> <i>Megachilidae</i> <i>Sphecidae</i>	Field breeding of entomophages is a key element of sustainable agriculture, especially in organic farming. It takes the place of an alternative or supplement to chemical treatments, increasing the environmental friendliness and economic efficiency of cultivation technologies. The aim of our research is to develop a method for using artificial shelters to attract and activate the natural potential of entomophages and pollinators of Hymenoptera insects in an agrocenosis. As a result of testing the design of artificial shelters to attract entomophages from the order Hymenoptera, the maximum number of bee nests (Megachilidae) were found in dark-colored plastic (70,8%) and cardboard (20,8%) cases. In 2024, an invasive species of digging wasps (Sphecidae) - <i>Isodontia mexicana</i> was obtained, identified and described from artificial shelters on the territory of the Institute of Genetics, Physiology and Plant Protection. The nests of the <i>I. mexicana</i> wasp were located in reed stems with a diameter of 0,7-1,0 cm, in cardboard deltoid white (40%) and dark (60%) artificial shelters. No wasp nests were found in plastic tubes and shelters with a plastic case. Solitary bees preferred to build nests in the pear orchard with the nectariferous plant area agrocenosis (91,7 %). <i>I. mexicana</i> nests were placed only in the apple orchard agrocenosis near the forest belt (100 %). The habitat associated with a multi-species, biodiverse landscape (forest belts, nectar plant areas, suburban areas, agroforests) promotes a large diversity of entomophages and pollinators (Hymenoptera) in the immediate vicinity of fruit crops. Due to the spatial proximity to the plantations, they ensure an early and rapid response of beneficial insects to the development of pest populations and, thus, can ideally prevent a strong spread of pests. The potential for economic use of the obtained Hymenoptera species was determined based on their biological characteristics: the ability of bees and wasps to populate anthropogenic cavities of suitable sizes and the wide polytrophism of species allow us to consider solitary bees (Megachilidae) and the invasive species of digging wasps (Sphecidae) – <i>I. mexicana</i> , as very promising species for field breeding in artificial shelters in order to increase the economic efficiency of agroecosystems. It is especially worth noting that <i>I. mexicana</i> is a promising species for biological plant protection, since it paralyzes its prey – Orthoptera pests: Gryllidae and Tettigoniidae, and places them in the nest to feed its larvae. As the population of <i>I. mexicana</i> increases, the most likely effect may be that the wasp will control locust pests of agricultural crops in the Republic of Moldova.

INTRODUCTION

Insects provide important ecosystem services of great economic value. Proper management of agro-landscape resources can contribute to the conservation of their biodiversity. In this context, agri-environmental schemes (AES) were included in the EU agricultural policy in 1985 and have become the main instrument for biodiversity conservation in Europe (Beyer et al., 2023). Field breeding of entomophages is a key element of sustainable agriculture, especially in organic farming. It takes the place of an alternative or supplement to chemical treatments, increasing the environmental friendliness and economic efficiency of cultivation technologies. It is an

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environmentally friendly method of pest control, reducing dependence on chemical pesticides. The main aspects of the field breeding of entomophages role:

- Biological plant protection (entomophages (predatory and parasitic insects, ladybugs, lacewings, Hymenoptera) are used to suppress pest populations (aphids, whiteflies, thrips, cutworms, etc.)
- Integration into cultivation technologies (inclusion in the integrated plant protection (IPM) system and combination with agrotechnical methods (sowing nectar plants, creating forest belts).

The attraction of beneficial insects is carried out by such technological methods as: a) placing artificial shelters for the safe reproduction, development and wintering of beneficial insects (Fabre hives); b) creation of reservations, sowing of nectar-bearing bait plants (nectar, pollen, shelter) to support natural insect's populations; c) placement of small reservoirs or drinking bowls for insects. Natural entomophages, attracted to the agroecosystem, natural entomophages settle in it, adapt to local conditions and become more active, which increases their survival and effectiveness. Field breeding can be more cost-effective in the long term for creating a self-sustaining ecosystem.

The main objectives of our research were to determine the species composition of *Hymenoptera* representatives that populated artificial shelters and to identify the most promising species for plant protection; to assess the influence of the type of agroecosystem on the intensity of their colonization; and also, to establish the degree of attractiveness of artificial shelters depending on the design and materials from which they were made. The aim of our research is to develop a method for using artificial shelters to attract and activate the natural potential of entomophages and pollinators of Hymenoptera insects in an agroecosystem.

MATERIALS AND METHODS

The research was carried out in laboratory and field conditions of the Institute of Genetics, Physiology and Plant Protection of the Republic of Moldova. The research was carried out during the vegetation period of 2024. The objects of the research were entomophages and pollinators of the Hymenoptera order.

We used hollow reed and plastic tubes in each shelter to evaluate the most attractive filler materials for colonization by beneficial Hymenoptera species. Four variants of the artificial shelter corps were examined: a) made of white and dark cardboard (natural material); b) made of transparent and dark plastic (synthetic material). In order to determine the most attractive elements of the agroecosystem for various species of attracted Hymenoptera, the experiment was conducted in three different biotopes. In early April, artificial shelters were placed at a certain height (1,5 m) above ground level, on supports. Biotopes of fruit orchards, forest belts and nectar-bearing plants were chosen as a food source (pollen, nectar) for the Hymenoptera imago. A field of *Miscanthus sinensis* provided the insects with a natural supply of tubular stems for nesting (Figure 1).

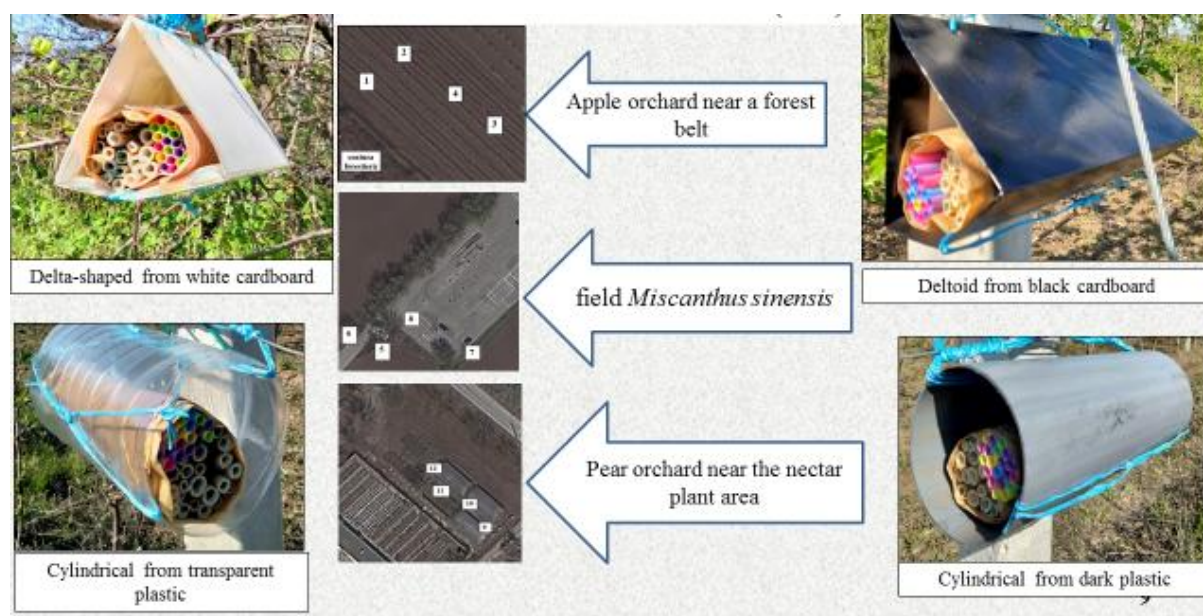


Figure 1. Layouts and types of artificial shelters to attract entomophages and pollinators of the order *Hymenoptera* (2024)

The obtained materials were examined. The insects were counted by sequentially inspecting of artificial shelters, determining the taxonomic affiliation of individuals and counting them.

RESULTS AND DISCUSSION

The number of Hymenoptera nests (bees and wasps) was found to depend on the type of artificial shelter and the type of agroecosystem. The maximum number of solitary bee's nests (Megachilidae) were found in artificial shelters made of dark plastic and dark cardboard (70.8% and 20.8%). (Figure 2a). Tubular reed stems (7–10 mm in diameter) were colonized, but no bee nests were found in plastic tubes. (Figure 2b). In the agroecosystem of the pear garden with a plot of nectar-bearing plants 91.7% of bees nested and in the *Miscanthus sinensis* field agroecosystem - 4.1%. In our studies, we obtained imagoes of solitary bees from two genera (Megachilidae): the genus *Osmia* (mason bees) and the genus *Stelis* (cuckoo bees). *Osmia* bees built their nests in tubular reed stems. Inside, the bees divided the passage into brood chambers. Each chamber was supplied with enough pollen to feed one larva. On each pollen mass, the bee laid an egg and sealed the chamber. For each subsequent chamber, the female bee collected pollen and laid eggs until the cavity was filled. The end of the tunnel was sealed with mud, plant resins, pieces of leaves, or flower petals. *Osmia* bees can be encouraged by placing artificial nests near nectar-bearing crops and gardens. The bees pollinate an extremely wide range of flowering plants. The relatively small *Stelis* bees lay eggs in the nests of other bees. Their parasitic larvae are active and have sharp mandibles with which they destroy the host's eggs or larvae. Since the *Stelis* larva consumes the stored food of its host, this form of parasitism is called kleptoparasitism. The hosts of *Stelis* are exclusively members of the Megachilinae, the same subfamily of bees to which the parasite itself belongs. In most cases, the parasite, having discovered the host's nest, returns to it repeatedly to lay an egg in each of several host cells before they close (Figure 2 c, d).



Figure 2. Solitary bees (Megachilidae): a) dark cardboard artificial shelters in the agroecosystem of the pear garden with a plot of nectar-bearing plants; b) The colonized tubular reed stems (7–10 mm in diameter); c) imago of the genus *Osmia* (mason bees); d) imago of the genus *Stelis* (cuckoo bees)

In 2024, an invasive species of digger wasps (Sphecidae) – *Isodontia mexicana* de – was isolated, identified and described from artificial shelters on the Institute of Genetics, Physiology and Plant Protection territory (Gladcaia, 2024). The taxonomic affiliation of the new species of wasp is as follows: class Insecta → order Hymenoptera → family Sphecidae → genus *Isodontia* → species *Isodontia mexicana* de Saussure, 1867 = *Sphex apicalis* de Saussure, 1867. Characteristic features of the species *Isodontia mexicana*: the first recurrent vein enters the second submarginal cell, the second recurrent vein enters the third submarginal cell; the body is completely black; the petiole is strongly curved in profile, the same length or longer than the tibia; the abdomen is without stripes of light hairs; the clypeus and the lower part of the frons are covered with long, erect black hairs (Notton, 2016). According to literary data, the species *I. mexicana* came from Central America to Europe (Italy) during World War II (in tree trunks and box cavities). The distribution of *I. mexicana* in its new range is limited to Europe. The

easternmost point of distribution in Europe is in Ukraine and Crimea, the northernmost is in the south of England, the westernmost is in northern Spain, and the southernmost is in Turkey (Can, 2024). The nests of the *I. mexicana* wasp were placed in reed stems with a diameter of 0,7–1,0 cm, in artificial shelters made of natural material (cardboard), white (40%) and dark (60%) colors. No wasp nests were found in plastic tubes and shelters with a plastic body. Thus, it was found that the wasp prefers a body and filler materials of shelters made of natural materials of a dark color. (Figure 3 a, b)

Imago of *I. mexicana* are anthophilous, while larvae are entomophagous. The presence of a relatively hairy mesosoma in *I. mexicana* adults and frequent visits to many flowering plants probably defines a new powerful pollinator. After leaving the nest, females mate with males and begin nest construction. The wasps use phytophagous insect larvae as prey. The female wasp stings the Orthoptera victim and immobilizes it; she then grabs the paralyzed prey under her body and carries it to the nest. Once the nest is filled with enough prey, she lays an egg. The larvae feed after hatching, and when food supplies are exhausted, each larva spins a cocoon for the pupa. Adults are often found in sunny, open areas such as meadows, gardens, and fields, where they search for prey and suitable nesting sites. (Figure 3 c, d)

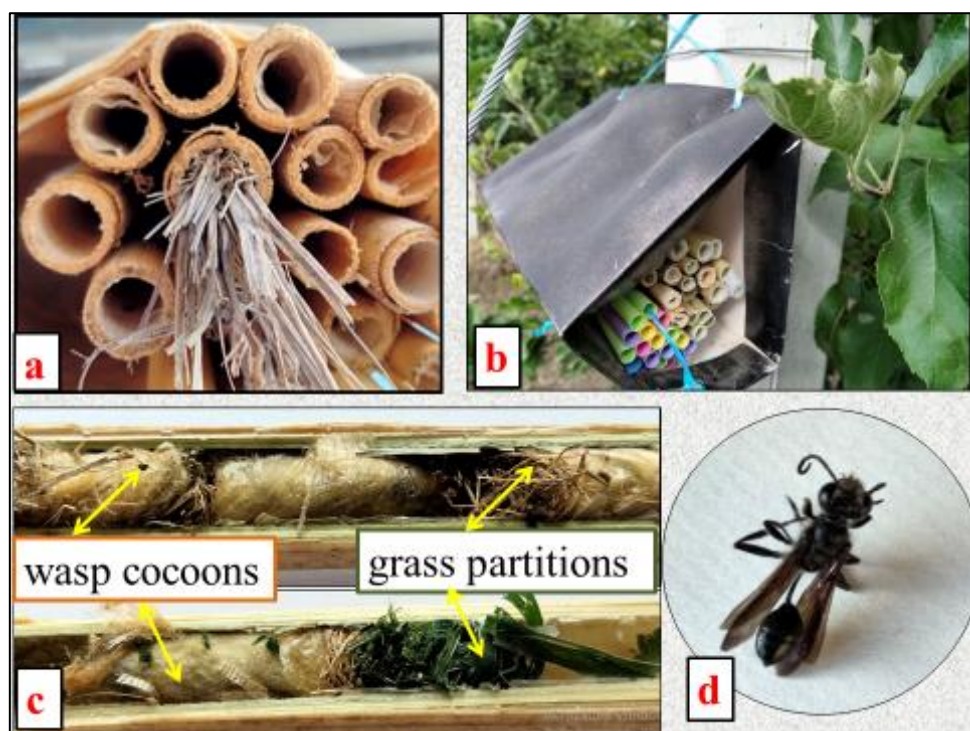


Figure 3. The nests of the *I. mexicana* wasp: a) the nests placed in reed stems with a diameter of 0,7–1,0 cm; b) the nests in artificial shelters made of natural material (cardboard); c) wasp cocoons and grass partitions inside the nest; d) imago of *I. mexicana*

All artificial shelters populated by the wasp (100%) were found only in the agrocenosis of the apple orchard near the forest belt (46°58'10.3"N 28°53'44.0"E). Our results are confirmed by the assertion of modern science that the solution to the problem of phytosanitary optimization of plant growing is feasible provided that plant protection is transferred to the ecosystem level, the fundamental principles of which are: agroecological adaptability, multivariance and environmental friendliness. In order to preserve biodiversity, maintain and activate the activity of entomophage's natural populations, implementation of protective measures in a forest-reclamation developed agrolandscape should be carried out taking into account the zonality of the forest-protected field and the bioecological characteristics of insects (Gribust et al., 2020). European scientists claim that the *I. mexicana* species has not changed its habitat and ecological niche in the captured territory. The habitat of the *I. mexicana* wasp is forests and forest-steppes, suburban areas, agricultural and cultivated lands, meadows and steppes (multispecies, biodiverse landscape) (Polidori et al., 2018). Based on this, the study of the composition and structure of insect communities in forest landscapes, in particular, protective forest plantations, is extremely important for developing methods for preserving the biodiversity of the entomofauna and activating the activity of entomophages. A network of semi-natural habitats (forest belts and areas of nectar crops), i.e. perennial areas of ecologically optimized landscapes sown with local wild grasses and extensively maintained forest edges, promotes a large diversity of beneficial insects in the immediate vicinity of fruit crops. Due to their spatial proximity to plantations, they ensure an early and rapid response of beneficial insects to the development of pest populations and, thus, can ideally prevent a strong spread of pests. The formation of a qualitatively new ecological environment leads to a

transformation of the entomofauna due to the introduction of mesophilic and entomophagous insect species that are not typical for treeless landscapes, which find optimal conditions for life and a rich trophic base in the developed agroecosystems. A study of the impact of forest reclamation in open agricultural areas showed that already in the first years after the creation of forest belts, atypical species (for example, *I. mexicana*) begin to be introduced into agroecosystems (Gribust et al., 2020). As the *I. mexicana* population increases, a more likely effect may be that the wasp will control locust pests of the Republic of Moldova agricultural crops.

Thus, we found that artificial shelters (modified Fabre hives) are an effective tool for attracting beneficial insects; the most promising for plant protection entomophagous Hymenoptera species, that populated artificial shelters, were identified; an assessment was made of the predominant influence of the ecologically optimized landscape factor on the intensity of its colonization by entomophages and pollinators.

CONCLUSION

As a result of testing the design of artificial shelters to attract entomophages from the order Hymenoptera, the maximum number of bee nests (Megachilidae) were found in dark-colored plastic (70,8%) and cardboard (20,8%) cases. In 2024, an invasive species of digging wasps (Sphecidae) - *Isodontia mexicana* was obtained, identified and described from artificial shelters on the territory of the Institute of Genetics, Physiology and Plant Protection. The nests of the *I. mexicana* wasp were located in reed stems with a diameter of 0,7-1,0 cm, in cardboard deltoid white (40%) and dark (60%) artificial shelters. No wasp nests were found in plastic tubes and shelters with a plastic case.

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