

MONITORING RARE HYMENOPTERA SPECIES (*ISODONTIA MEXICANA*, DE SAUSSURE, 1867) IN THE REPUBLIC OF MOLDOVA USING ARTIFICIAL REFUGEES, AND NEW DATA ON THE SPECIES *TREMEX FUSCICORNIS*, FABRICIUS, 1787

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KEYWORDS	ABSTRACT
<i>Isodontia mexicana</i> <i>Tremex fuscicornis</i> Moldova Artificial shelters Climate change Biological control	As a result of monitoring of Hymenoptera species on the territory of the Republic of Moldova using artificial shelters (Fabre's nest with dry hollow stems of <i>Phragmites</i> and <i>Reynoutria</i>) and hand-collecting methods during 2024–2025, new data on the distribution of two alien species were obtained. A rare species has been discovered in the central part of the country - <i>Isodontia mexicana</i> de Saussure, 1867 (Hymenoptera: Sphecidae) in cardboard artificial shelters placed in an apple orchard and on an aromatic plant plantation. A detailed morphological description of the species is provided, including diagnostic characters of the adult, as well as data on life cycle, ecology and potential role as a pollinator and regulator of orthopteran populations. Furthermore, the current status of <i>Tremex fuscicornis</i> , Fabricius, 1787 (Hymenoptera: Siricidae) is clarified, with a female specimen collected by hand in a forest shelterbelt in the central region of the country. A detailed morphological description of the female is presented, including the structure of the head, thorax, abdomen, ovipositor and wings. The distribution of the species in Europe, its biology, trophic relationships with the symbiotic fungus <i>Cerrena unicolor</i> and host species (deciduous trees) were analyzed. It is shown that climate change (increasing average annual temperatures, increased drought frequency) creates favorable conditions for the naturalization and potential outbreak of <i>T. fuscicornis</i> as a secondary pest of weakened tree stands. Measures for monitoring and protecting plants have been proposed, including sanitary felling and the conservation of natural parasitoids – wasps of the genus <i>Megarhyssa</i> , Ashmead, 1858 and <i>Ibalia</i> , Latreille, 1802. Species of <i>Isodontia mexicana</i> has potential as a biological control agent against orthopteran pests and as a pollinator, whereas <i>Tremex fuscicornis</i> is a secondary forest pest causing damage to tree stands and timber.

INTRODUCTION

The territory of the Republic of Moldova, situated at the crossroads of several European biogeographical regions, has traditionally been characterized by a high level of insect biodiversity. However, recent decades have witnessed a substantial transformation of the entomofauna, driven by active invasion processes. Against the backdrop of rising average annual temperatures observed in the region (data from terrestrial weather stations for the period 1991–2024), an expansion in the ranges of thermophilic hymenopteran species is being recorded. Over the past 20 years, 23 new invasive insect species have been registered on the territory of the Republic of Moldova, the majority of which pose a potential threat to forest and agricultural ecosystems. Among the order Hymenoptera, two new rare species (*Isodontia Mexicana* и *Tremex fuscicornis*) have been recorded by us during this period, making each new registration particularly significant for monitoring the region's biosecurity. This article presents the results of monitoring Hymenoptera in the Republic of Moldova various biotopes using artificial shelters and hand-collecting methods. *Isodontia mexicana* de Saussure, 1867 (detected in an artificial shelters) is recorded for the first time from the fauna of the country, and the current status of *Tremex fuscicornis*, Fabricius, 1787 (detected in a forest

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shelterbelt by hand-collecting) is clarified. The role of climate change as a driver of northward range expansion in these species is discussed.

Imago and nests of *I. mexicana* (f. Sphecidae, or digger wasps) species was first reared from artificial shelters on the territory of the Institute of Genetics, Physiology and Plant Protection, and these data were published in 2024 році (Gladcaia, 2024). The invasion route of *I. mexicana* into Europe spans several decades: having spread from Central America during the Second World War, the species has progressively expanded its range — from southern France (1960s) through Spain, Hungary and Serbia to the Crimea (2014), and then to the Donbas region (2015). This species demonstrates an intriguing balance, from a research perspective, between its potential harmfulness (as an alien taxon) and its beneficial properties—notably its ability to control orthopteran pest populations and to act as an effective pollinator due to its pubescent mesosome (Gladcaia, 2024).

By contrast the *Tremex fuscicornis*, Fabricius, 1787 (family Siricidae, or horntail wasps) species, has a longer history of observations in Europe. Although *Tremex fuscicornis* has been found in England and Scotland, the species has not become established in these territories and is regarded as introduced only. The species' classification as a horntail indicates its specialisation as a xylophage: larvae develop in weakened or dead deciduous wood, which potentially places it among the factors capable of affecting the sanitary condition of forest stands. Unlike *I. mexicana*, *T. fuscicornis* remains poorly studied in the context of the Moldovan fauna, necessitating a comprehensive analysis of existing data.

The aim of this review is to summarize information on the biology, dispersal pathways and potential ecological impact of these two hymenopteran species within the Republic of Moldova territory. Particular attention is paid to analyzing their possible roles in agroecosystems and natural ecosystems, identifying potential threats, and assessing the prospects of using synanthropic traits in biological monitoring and plant protection programmes.

MATERIALS AND METHODS

Artificial shelters (3 in each biotope) were deployed during the 2024-2025 growing seasons (March–September) across five biotopes in the Republic of Moldova: Botanical garden and forest shelterbelt (46°58'30.0"N 28°52'50.1"E); an apple orchard, an aromatic plant plantation and a agroforest (46°58'10.3"N 28°53'44.0"E). Nest boxes (cardboard and plastic variants) were oriented with their front faces to the south and east, fixed at a height of 1,5 m above ground level. Two types of filling materials for artificial shelters: hollow stems of reeds (*Phragmites*) and renutria (*Reynoutria*) - 20 pieces each (Figure 1).



Figure 1. Artificial shelters for entomophages, predators and pollinators of the order Hymenoptera in various biotopes
a) cardboard body; b) plastic body

When all insects that had colonized the artificial shelters entered diapause (December), the shelters were moved to natural conditions (the laboratory balcony) of the institute until February of the following year. Before the approach of the spring temperature increase (end of February), the dormant insects were transferred to the laboratory (+17°C) and sorted into Petri dishes, test tubes (with cotton plugs), and cylinders (covered with thin cloth). Entomophage imagoes were identified immediately. Wasps and bees were identified in the laboratory as they emerged. Recording, identification and photographic documentation were carried out using an up-to-date key to the fauna of north-western Europe: Schiff et al. (2012) for Siricidae and Notton (2016) for Sphecidae.

RESULTS AND DISCUSSION

Isodontia mexicana de Saussure, 1867 (Hymenoptera: Sphecidae)

As a result of emergence from the nests, adults of *Isodontia mexicana* were obtained. This wasp species was first discovered in an apple orchard near a forest shelterbelt, and the following year – in the aromatic plant biotope. The nests were located in cardboard artificial shelters, within reed stems of 0,7–0,9 cm diameter. Artificial shelters with plastic housing contained no wasp nests. Thus, nests, pupae and adults of *Isodontia mexicana* were obtained, photographically documented and deposited in the collection (Figure 2).



Figure 2. Species *Isodontia mexicana* de Saussure, 1867 (Hymenoptera, Sphecidae)
a) *I. mexicana* geolocation and biotope of the location; b) adult habitus (photo by the author)

Diagnostic characters of the genus *Isodontia* Patton, 1880

The first recurrent vein enters the second submarginal cell, the second recurrent vein enters the third submarginal cell; body entirely black. Recording, identification and photographic documentation of *Isodontia mexicana* were carried out using a key to the fauna of north-western Europe. Within the Sphecidae fauna of the Republic of Moldova, *I. mexicana* is immediately distinguished by its uniformly black coloration.

Diagnostic characters of *Isodontia Mexicana*

Metasoma entirely black; dorsal area finely punctate and worn, but showing only traces of transverse striation; petiole strongly curved in profile, as long as or longer than the hind tibia (Figure 3b); metasoma without bands of pale setae; clypeus and lower frons with long, erect, black setae (Figure 3c); anterior margin of female clypeus with a small, deep median emargination bounded on each side by a tooth; wings smoky, darker along the apical margin; male antennae without distinct placoids (Figure 3).

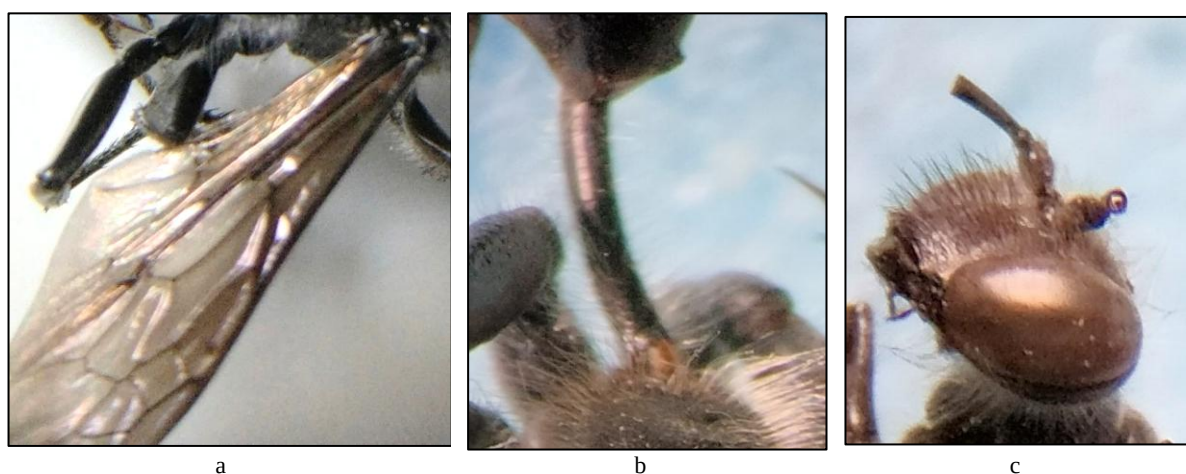


Figure 3. *Isodontia Mexicana*
a) right forewing; b) curved petiole; c) head in lateral view (photo by author)

Thus, the **taxonomic classification** of the new wasp species is as follows: class Insecta → subclass Pterygota → infraclass Neoptera → order Hymenoptera → suborder Apocrita → superfamily Apoidea → family Sphecidae →

subfamily Sphecinae → tribe Sphecini → genus *Isodontia* → species *Isodontia mexicana* de Saussure, 1867 = *Sphex apicalis* de Saussure, 1867 = *Sphex apicalis mexicana* de Saussure, 1867 (Notton, 2016).

In the climatic zone, to which the Republic of Moldova belongs, the wasp *I. mexicana* typically produces one summer generation of offspring in the nests and overwinters as prepupae, then pupates and emerges as adults in spring. After emergence from the natal nest, females mate with males and begin nest construction. Unlike most Sphecidae wasps, which nest in burrows underground, grass-carrying wasps usually choose nesting sites above ground, in tree cavities. The egg is laid in a protected environment (hollow branches or plant stems). It is small, oval and typically attached to the substrate inside the nest. The larva, after hatching, appears vermiform with a soft, elongated body. It has no wings, and its head possesses chewing mouthparts for consuming food (adults provision it with paralyzed prey – Orthoptera). The larva is primarily focused on growth, moulting multiple times to increase its size. As a pupa, the wasp undergoes significant changes within a protective cocoon, as the wings and adult body form. The adult, emerging from the pupa, displays wings and functional reproductive organs. The exoskeleton hardens, and the body acquires its characteristic coloration. *I. mexicana* is a pollinator, demonstrating very clear preferences for plants of the families Lamiaceae, Asteraceae, Fabaceae and Apiaceae. Adults are often found in sunny, open places such as meadows, gardens and fields, where they search for prey and suitable nesting sites. *I. mexicana* can cause toxic reactions with a wide range of severity. However, the toxins are generally targeted at its prey and predators. To humans, they are usually not lethal. Predators dangerous to adult *I. mexicana* include birds, spiders and mantises.

According to the history of range expansion of *I. mexicana*, the species arrived from Central America to Europe (Italy) during the Second World War. *I. mexicana* has not altered its ecological niche within the invaded territory. The wasp has demonstrated a clear tendency to occupy areas with moderate winter temperatures, low precipitation during the driest period of the year, and low altitudes. The habitat of *I. mexicana* includes forests and forest-steppes, urban and suburban areas, agricultural and cultivated zones, meadows and steppes (Europe, Ukraine, Crimea). Scientists predict that *I. mexicana* may spread further across Europe and Asia, reach new, as yet unoccupied continents in the Southern Hemisphere, and become established there (Polidori, 2018). The discovery of *I. mexicana* on the territory of the Republic of Moldova confirms this prediction.

***Tremex fuscicornis*, Fabricius, 1787 (Hymenoptera: Siricidae)**

In September 2025, a female adult of a new rare Hymenoptera species was discovered in a forest shelterbelt species for the fauna of Moldova (Figure 4).



Figure 4. The species *Tremex fuscicornis*, Fabricius, 1787), *Tremex*, Jurine, 1807, Siricidae, Hymenoptera
a) *T. fuscicornis* geolocation and biotope of the location; b) *T. fuscicornis* ♀ adult habitus (photo by the author)

The *Tremex fuscicornis*, found by us in the central region of the Republic of Moldova, have long setae covering their body. For example, the setae of the frons, in dorsal view, are approximately the same length as or longer than the distance between the inner edges of the lateral ocelli. The cornus does not protrude in dorsal view and has an angular shape along the ventral margin at the base.

Head is brown. Antennae are brown and black on middle segments. Mandible black. Pronotum reddish-brown and black laterally. Metathorax black. Coxae black. Pro- and mesofemur reddish brown, and metafemur mostly black; tarsus pale yellow. The wings are yellowish-brown. Tergum 1 and 2 are black, tergum 9 is central, and tergum 10 is mostly yellow. Sternae 2–7 are black at the basal ends and brown at the apical ends. The sheath is brown (Figure 5).

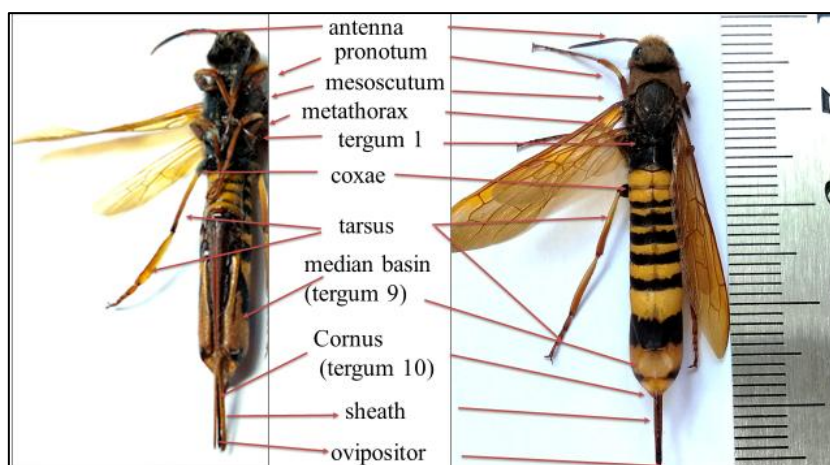


Figure 5. *T. fuscicornis* ♀: ventral view (Venter) and dorsal view (Dorsum) (photo by the author)

Head. Frons in lateral view with setae on the frons as long as or longer than the distance between the lateral ocellus, and with predominantly adjacent and small punctures (diameter approximately 0,3 times the diameter of a lateral ocellus). Antennae with 13 antennomeres; middle flagellomeres in dorsal view 0,8–0,9 times as long as their width (Figure 6).

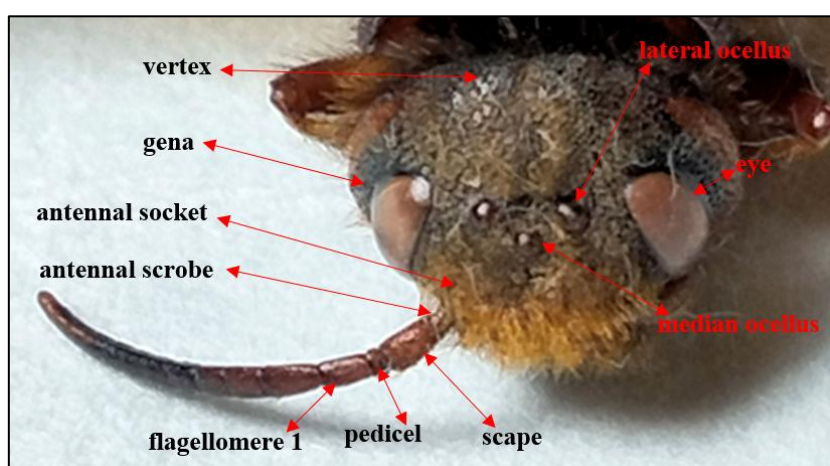


Figure 6. *T. fuscicornis* ♀ head (photo by the author)

Thorax. Pronotum in dorsal view with numerous large teeth on the surface. Forewing with length of cell 2R1 1,2–1,5 times the length of cell 3R1 (Figure 7).



Figure 7. Forewing of *T. fuscicornis* ♀ (photo by the author)

The abdomen is covered with long and sparse setae on the median area of terga 1, 5 and 6. Tergum 10 in dorsal view 1,1–1,2 times as long as the median length of the median depression. Lancet of ovipositor with approximately 12 annuli, and with the outline of annuli only below the apical part of the sheath (Figure 8). Thus, the taxonomic classification of the new wasp species is as follows: class Insecta → subclass Pterygota → infraclass Neoptera → order Hymenoptera → suborder Apocrita → superfamily Apoidea → family Siricidae, Billberg, 1820; genus *Tremex* Jurine, 1807; species *Tremex fuscicornis*, Fabricius, 1787 (Schiff, 2012).

The natural range of *T. fuscicornis* extends across large areas of Eurasia to Japan. It is widespread in deciduous and mixed forests of Europe and Asia. It is found from Great Britain and Scandinavia to the Far East, Siberia, Japan, and China. In recent decades, the species was accidentally introduced and successfully established in the Southern Hemisphere. The pest has been recorded in Australia and South America (Chile, Argentina) (Figure 9).

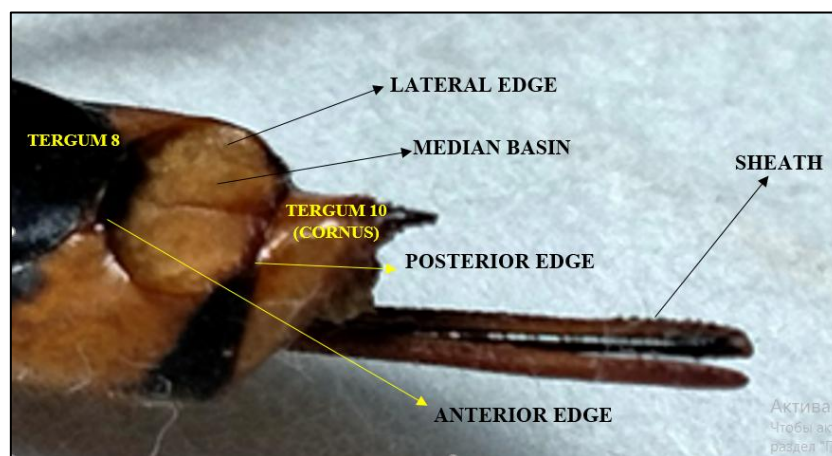


Figure 8. *T. fuscicornis* ♀: cornus, sheath, ovipositor (photo by the author)

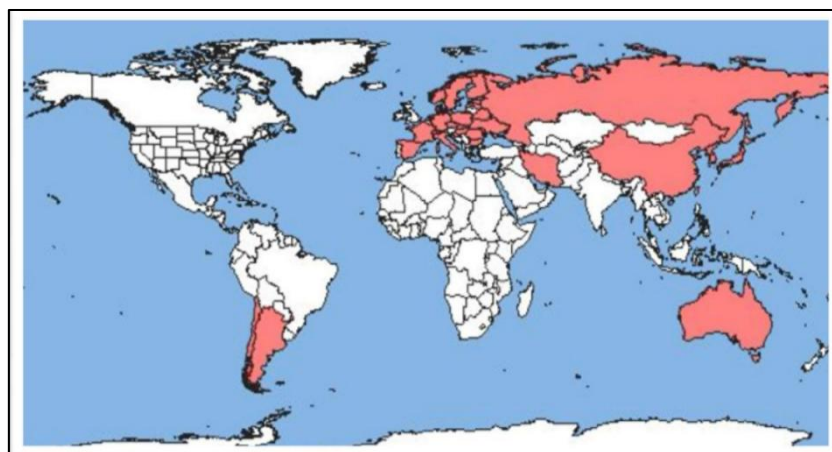


Figure 9. *T. fuscicornis* (Fabricius, 1787) species distribution map (GBIF, 2022)

In northern Germany, the first indications of the presence of *T. fuscicornis* date back to the 19th century: the species was recorded in 1874 in Kiel (on a telegraph pole). In the Netherlands and Belgium, *T. fuscicornis* was first recorded in 1999 and 2002, respectively, and finds of its parasitoids (*Megarhyssa* spp.) are also becoming more frequent there. It is assumed that the increase in records is related not only to anthropogenic transport (via timber, firewood, packaging) but also to ecological factors: the species likely benefits from drought-induced dieback of deciduous trees, which expands its food base and facilitates natural dispersal (Sonnenburg, 2022).

The biology of *T. fuscicornis* is poorly studied, mainly because this pest often remains hidden inside its host plant. Adult horntail wasps feed exclusively on tree sap. *T. fuscicornis* requires deciduous wood for oviposition and larval development. It occurs predominantly on trees of the genera *Betula* spp. and *Populus* spp., as well as on *Acer* spp., *Alnus* spp., *Carpinus betulus*, *Juglans regia*, *Fagus* spp., *Prunus* spp., *Quercus* spp., *Salix* spp., *Sorbus* spp., *Ulmus* spp.

Its life cycle (depending on the climatic zone and degree of wood decomposition) lasts at least two years. Adult wasps typically mate on the upper branches of trees. Females select weakened or damaged trees for oviposition, laying 300–400 eggs into the cambium. Eggs are deposited at an angle, at some distance from each other, but clustered within the wood. Like other suicides, members of the genus *Tremex* are associated with the basidiomycete wood-degrading fungus *Cerrena unicolor*, Bull. Murrill, 1903; genus *Cerrena*, Gray, 1821; family Polyporaceae, Fr. ex Corda, 1839; class Agaricomycetes, Doweld, 2001; kingdom Fungi, R. T. Moore, 1980. In this symbiotic relationship, the fungus is transported to new host trees in specialized mycangia of the adult female and then deposited under the bark or cambial layer when the female inserts her ovipositor into the tree for oviposition. The fungus breaks down cellulose in the host tree using digestive enzymes and provides a food source for the developing larvae (Hardin, 2013). The question of whether developing suicides feed on digested wood products or exclusively on the fungus remains inadequately studied. The larvae gradually penetrate the host's

wood, creating longitudinal semicircular tunnels up to 1-meter long. Pupation occurs at a depth of approximately 4 cm within the wood. The larvae require 1-3 years to fully develop, and adults typically emerge in late summer or autumn. During monitoring, it is necessary to pay attention to the presence of uneven round holes for the exit of adults, especially on dry branches or dying trees. Damage may remain unnoticed until the appearance of frass (boring dust) and circular exit holes in the wood (Figure 10).

The overall climatic situation in Moldova is characterized by rising average temperatures, especially winter temperatures, and an increased frequency and intensity of droughts and heatwaves. The annual European State of the Climate (ESOTC) reports consistently show that Europe is the fastest-warming continent (PESI, 2025; ESOTC, 2023).

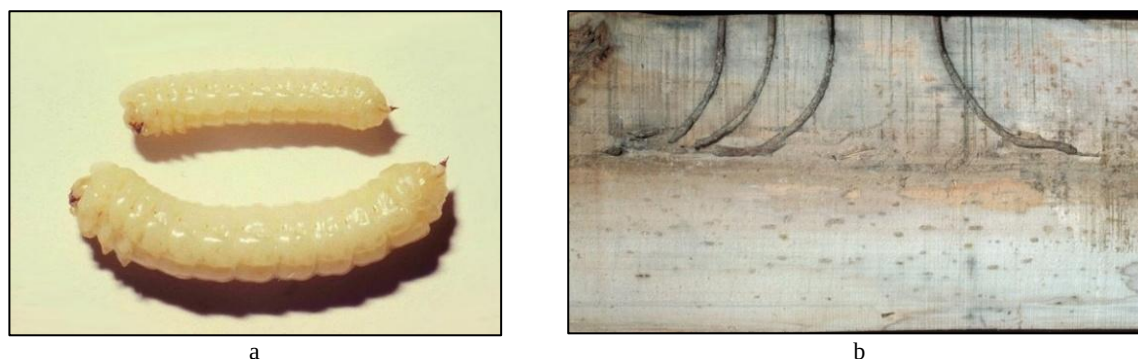


Figure 10. Larva (a) and galleries (b) of *T. fuscicornis* in wood

In 2023, the average temperature was 1,02–1,12°C above the 1991–2020 norm. Southeastern Europe, including Moldova, consistently exhibits positive temperature anomalies, particularly pronounced during winter and summer months. FAO documents and reports from national forest services in Eastern European countries document large-scale forest dieback, especially of ash and beech forests, across Europe, caused by the complex of "drought + pathogens + pests". For example, reports from Romania and Ukraine record the loss of thousands of hectares of forest (FAO, 2023) (Table 1).

Table 1. Favorable conditions for the *Tremex fuscicornis* species as a result of climate change in Moldova

Aspect	<i>Tremex fuscicornis</i>	Climate change in Moldova	Effect on the species in Moldova
Temperature regime	Mild winters increase the survival rate of larvae in wood	An increase in average temperatures, especially in winter. Milder and shorter winters.	Reduction in winter mortality. Successful overwintering and population growth.
Humidity Precipitation	Depends on the wood's moisture content. Severe drought can make the wood too hard for the ovipositor to penetrate and the larvae to develop.	Increased frequency and duration of droughts. Increased frequency of extreme weather events.	For <i>T. fuscicornis</i> : the effect is twofold. Drought weakens trees (a plus), but can also dry out the wood too much (a minus). Overall, the plus outweighs the minus.
Forage base	A secondary pest of weakened deciduous trees. Its development is dependent on the symbiotic fungus <i>Cerrena unicolor</i> .	Climate stress in trees: droughts and heat waves weaken tree stands. The number of weakened and dying trees is increasing.	A sharp increase in the food supply for <i>T. fuscicornis</i> . Massive forest dieback creates ideal conditions for a population explosion.
Phenology/ Life Cycle	Long development cycle (2 years). Adult flight from July to September.	Extending the growing season. Earlier spring and later fall.	For <i>T. fuscicornis</i> : a longer period for flight, mating and egg laying.

Summarizing the available data, it can be concluded that climate change in Moldova acts as a systemic catalyst, creating a range of favorable conditions for this species. For *T. fuscicornis*, the key factor is the large-scale weakening of tree stands due to droughts and heatwaves. Climatic anomalies are transforming it from a rare species into a widespread and economically significant secondary pest. Milder winters also contribute to more successful larval overwintering. Our conclusions are consistent with ecological principles and models proposed by international researchers. In a classic work on forest entomology, Berryman, (1986) clearly formulated the principle: outbreaks of secondary pests (bark beetles, horntails, longhorn beetles) invariably follow events that weaken tree stands (drought, storms, fires, industrial emissions). Climate change represents a global, continuously acting weakening factor. *T. fuscicornis* is a secondary pest. Its outbreak depends not directly on its own population size but on the condition of forests. The probability of an outbreak is very high, albeit delayed in time. At this accumulation phase, a small local population exists, reproducing on isolated weakened trees. Only one or two years of severe drought (which is becoming the norm) are sufficient for massively weakened and dying ash, poplar and beech trees to appear in Moldova's forests. Female *T. fuscicornis* locate these weakened trees. The vast food

base allows them to lay the maximum number of eggs. Within 1–3 years (the larval development time), hundreds of times more adults may emerge from these trees, which in turn will attack newly weakened trees. Such a self-sustaining outbreak may continue until the suitable food base is exhausted. Economic losses caused by this pest may include the accelerated dieback of weakened trees in forest parks, urban plantings and forests, as well as timber degradation.

Plant protection from *T. fuscicornis* comes down to classic forestry methods: maintaining forest health and timely sanitary felling. The strategy should be aimed at containing the population and minimizing damage, rather than outright eradication, which is often impossible for naturalized species. A natural parasitoid of *T. fuscicornis* are the ichneumonid wasp genus *Megarhyssa*, Ashmead, 1858; family Ichneumonidae Haliday, 1838. The larvae parasitize horntail larvae. The wasp genus *Ibalia*, Latreille, 1802; family Ibalidae, Thomson, 1862 is a specialized parasitoid of the larvae of the horntail moth *T. fuscicornis*. These wasps locate their prey deep within wood by the scent of the fungus carried by the moths.

CONCLUSION

1. A new rare species of digger wasp, *I. mexicana* (Hymenoptera: Sphecidae), is recorded for the Republic of Moldova fauna, identified in 2024 on the territory of the Institute of Genetics, Physiology and Plant Protection. The taxonomic (in accordance with modern taxonomic keys) and biological characteristics of the species and the potential for its use in plant protection were analyzed:
 - a. Wasps of the species *I. mexicana* were recorded in the biotope closest to the forest belt and in the spice plants plantation. This is a major factor in providing food, nesting sites and shelter and helps attract insects to feed, breed and overwinter in these biotopes;
 - b. The presence of a relatively pubescent mesosome and the frequent visitation of many flowering plants (Lamiaceae, Asteraceae, Fabaceae, Apiaceae) by *I. mexicana* likely qualify this species as a new and effective pollinator;
 - c. In the case of *I. mexicana*, the prey taxa (Gryllidae and Tettigoniidae) are generally quite abundant and diverse, whereas across much of Europe there are relatively few Sphecidae that hunt Orthoptera. As the population of *I. mexicana* grows, a more likely outcome is that the wasp could contribute to the control of orthopteran agricultural pests. We emphasize the need for long-term insect monitoring and for increased attention within future agri-environment schemes to the creation of nesting sites for the effective conservation and population increase of *I. mexicana*.
2. In the central region of the country, we discovered an adult female *T. fuscicornis* (Hymenoptera: Siricidae) by hand collection and clarified the current status of the horntail. A detailed morphological description (coloration, head and mesonotum sculpture, tergites, wing venation, and ovipositor structure) is provided in accordance with modern taxonomic keys. The species is a xylophage, developing in weakened or dead deciduous wood of deciduous trees (*Betula*, *Populus*, *Acer*, *Alnus*, *Fagus*, *Quercus*, etc.), and maintains an obligate symbiosis with the wood-destroying fungus *Cerrena unicolor*, which is carried by females in their mycetomes and provides nutrition for the larvae. In the context of climate change, characterized by an increase in average annual temperatures in the Republic of Moldova (anomaly +1,02–1,12°C in 2023 relative to the 1991–2020 norm), more frequent droughts and heat waves, and mild winters, creates favorable conditions for the growth of thermophilic species, including *T. fuscicornis*. According to the principles of population ecology, the widespread weakening of ash, poplar, and beech stands as a result of droughts could trigger a delayed outbreak of *T. fuscicornis*. The species could transition from a rare to an economically significant pest, causing damage to forest parks, urban areas, and natural spaces.

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