

# INVERTEBRATES INHABITING CULINARY HERBS GROWN UNDER COVER

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**Abstract:** The study contains the list of invertebrates collected from culinary herbs (*Allium schoenoprasum*, *Anethum graveolens*, *Anthriscus* sp., *Petroselinum crispum*, *Coriandrum sativum*, *Artemisia dracunculus*, *Eruca sativa*, *Melissa officinalis*, *Mentha arvensis*, *Mentha x piperita*, *Ocimum basilicum*, *Origanum majorana*, *Origanum vulgare*, *Salvia officinalis*, *Thymus vulgaris*, *Rosmarinus* sp.) in greenhouses, under plastic-film covers, and at mother farms. The study provides information about the times of the year when these invertebrates settle on the herbs, and about the specific character of cultivating such plants. Even a few individual arthropods on culinary herbs cannot be tolerated and eliminating arthropods by using chemicals is unacceptable. For these reasons, those plants on which the arthropods have settled must be removed from greenhouses and destroyed. Biological pest control is also recommended. Some species of the observed invertebrates are encountered in a greenhouse year-round (*Myzus persicae*, *Aphis gossypii*, *Ovatus mentharius*, *Aulacorthum solani*, *Eupteryx* sp., *Trialeurodes vaporariorum*, larvae of Thysanoptera) while others appear only during the periods of spring migrations (*Cavariella aegopodi*) or autumn migrations (*Aphis fabae*, *Dysaphis crataegii*, butterflies from the subfamily Hadeninae). Peppermint had already been inhabited by *O. mentharius* on mother farms, and *O. mentharius* probably hibernated on farms as well. Potted peppermint seedlings brought from mother farms to greenhouses had already been inhabited by that aphid species. Some invertebrates were associated with a substrate (Sciaridae) while the appearance of others coincided with the development of algae (Ephydriidae: *Scatella* sp.).

**Key words:** culinary herbs, greenhouses, insects and other animals

## INTRODUCTION

Wide-scale cultivation of culinary herbs in Poland has recently begun. More and more such cultivations are being established throughout the country. Presently, culinary herbs can be bought in small plastic pots in most large grocery stores. The fauna of those plants has not been studied so far. Various species of invertebrates occur on culinary herbs and contaminate them. The producers have to remove the inhabited plants, since no buyer wants culinary herbs with aphids or snails. However, it is possible to use methods of biological pest control in culinary herb cultivation.

Culinary herbs cultivated in greenhouses were placed on movable cultivation gutters. Rosemary, peppermint, and field mint were propagated from seedlings collected from mother farms. Chives were sown in pots on the field and left in the open until the first ground frost of the season. After the first frost, the pots were taken to a freezer, and then systematically, as the need arises, put into plastic pots and brought to a greenhouse. The remaining culinary herbs were sown directly into pots and put on the gutters.

On such gutters, contrary to other greenhouse cultivations, the time of growth is very short. Only rosemary and

mint last for about 8 weeks. The other herbs last between 3 and 4 weeks. During that short period the invertebrates do not usually become very numerous and inhabit about 10% of the herbs at the most. Only during the periods of aphid migrations in the spring and in the autumn, have more numerous appearances of those insects been observed. However, regardless of the number, the plants on which the insects have settled have to be destroyed, which generates serious losses. For instance, during the first quarter of 2013, out of 70 thousand pots of basil, 3 thousand had to be destroyed, *i.e.* as much as 2.3% of the total number of plants.

## MATERIAL AND METHODS

The research was conducted in 2010–2012 in the surroundings of Warsaw, Poland, and during the first quarter of 2013 in a nearly 2 ha production greenhouse designed especially for cultivating culinary herbs, and under two plastic-film covers with a total area of about 800 m<sup>2</sup>. Apart from that, mother farm fields of peppermint, garden mint, and rosemary were monitored during a one-year period. Production of mother plantings was also established in greenhouses but situated at considerable distances from

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the culinary herb cultivations. The research encompassed 16 species of culinary herbs, representing 5 families:

- Amaryllidaceae: chives (*Allium schoenoprasum* L.);
- Apiaceae: dill (*Anethum graveolens* L.), chervil (*Anthriscus* sp.), parsley (*Petroselinum crispum* (Mill.) Fuss), coriander (*Coriandrum sativum* L.);
- Asteraceae: tarragon (*Artemisia dracunculus* L.);
- Brassicaceae: salad rocket (*Eruca sativa* Mill.);
- Lamiaceae: lemon balm (*Melissa officinalis* L.), field mint (*Mentha arvensis* L.), peppermint (*Mentha x piperita* L.), basil (*Ocimum basilicum* L.), marjoram (*Origanum majorana* L.), oregano (*Origanum vulgare* L.), sage (*Salvia officinalis* L.), thyme (*Thymus vulgaris* L.), rosemary (*Rosmarinus* sp.).

The present research has a preliminary character. All plant pots for sale (about 500 pieces) were placed on gutters and inspected every 6–7 days. The plants on which insects had settled were selected and the species that inhabited them were identified. The mother plantings of peppermint, and garden mint as well as rosemary were inspected every 14 days for one year. Apart from that, yellow sticky boards were hung out in greenhouses to monitor the appearance of particular species in the investigated culinary herb cultivations. Collected animals were identified with respect to their species or at least orders. In the case of snails, however, such an identification was not always possible, since only very small young specimens were found. Names of invertebrates were given after Fauna Europaea (2012).

## RESULTS AND DISCUSSION

The representatives of the following groups of invertebrates were found on the studied plants: Thysanoptera, Hemiptera (Aphididae, Aleyrodidae and Cicadellidae), Lepidoptera (Noctuidae: Hadeninae), and Diptera (Sciaridae). *Scatella stagnalis* (Fallen 1823) from the family Ephydriidae was found on the algae that sometimes appeared as well. That particular fly species caused problems for the people working in the greenhouse because it caused eye irritation. Slugs and snails were observed in mother plantings of rosemary and peppermint. However, not all of the studied plants were inhabited by invertebrates. The list of invertebrates inhabiting culinary herbs is shown in table 1.

### A review of the invertebrates found on the culinary herbs

#### The Thysanoptera

Characteristic lesions, which were not very numerous, were found on *A. schoenoprasum*, *M. x piperita*, *O. basilicum*, and *Rosmarinus* sp. Adult thrip specimens were found on yellow sticky boards. No second stage larvae were found on the plants that would make it possible to identify the species. On a single occasion in 2013, several thrip larvae (first stage) were found on basil and on peppermint. It is probable that the source from which those insects originated was the chives brought from the field and put into the freezer, to be

Table 1. The list of invertebrates inhabiting culinary herbs

Invertebrates	Culinary herbs									
	<i>Allium schoenoprasum</i>	<i>Anethum graveolens</i>	<i>Petroselinum crispum</i>	<i>Eruca sativa</i>	<i>Melissa officinalis</i>	<i>Mentha arvensis</i>	<i>Mentha x piperita</i>	<i>Ocimum basilicum</i>	<i>Thymus vulgaris</i>	<i>Rosmarinus</i> sp.
Larva of Thysanoptera	+	-	-	-	-	-	+	+	-	+
<i>Trialeurodes vaporariorum</i>	-	-	-	-	-	-	-	-	-	+
<i>Eupteryx</i> sp.	-	-	-	-	+	+	+	-	-	+
<i>Aphis gossypii</i>	-	-	+	-	-	-	-	-	-	+
<i>Aphis fabae</i>	-	-	+	-	-	-	-	-	-	-
<i>Aulacorthum solani</i>	-	-	-	-	-	-	-	+	-	-
<i>Cavariella aegopodii</i>	-	+	-	-	-	-	-	-	-	-
<i>Dysaphis crataegi</i>	-	-	+	-	-	-	-	-	-	-
<i>Myzus persicae</i>	-	-	-	+	-	-	+	+	-	-
<i>Ovatus mentharius</i>	-	-	-	-	-	-	+	-	-	-
Larva of Hadeninae	-	-	-	-	-	+	+	+	-	-
Larva of <i>Agrotis</i> sp.	+	-	-	-	-	-	-	-	-	-
Larva of Sciaridae [in soil]	+	+	+	+	+	+	+	+	+	+
Snails	-	-	-	-	-	-	-	-	-	+
Slugs	-	-	-	-	-	-	+	-	-	-

subsequently moved to the greenhouse. The presence of onion thrips was recorded on the chives while the chives were still in the field.

The predatory mite *Amblyseius cucumeris* (Oudemans 1930) was introduced as a preventative measure against the thrips. As the numbers of thrips found on the yellow sticky boards grew, predatory hemipteran insects from the genus *Orius* were additionally introduced.

#### The Hemiptera: Aleyrodidae

*Trialeurodes vaporariorum* (Westwood 1856) was encountered in large numbers in the studied greenhouses: as many as 50 individuals were found on a single plant. However, the species settled solely on *Rosmarinus* sp., probably due to the fact that *Rosmarinus* sp. stayed in the greenhouse for a prolonged period of time (about 8 weeks). The development of one generation of that species typically took about a month (Goszczyński 1988). Adult individuals were caught on the yellow sticky boards. In order to combat the larva of that hemipteran insect, the parasitic hymenopteran species *Encarsia formosa* Gahan 1924 and the predatory mite *Amblyseius swirskii* Athias-Henriot 1962 were introduced.

#### The Auchenorrhyncha

Representatives of the genus *Eupteryx* were encountered in greenhouses all year round, on the herbs from the family Lamiaceae: *M. officinalis*, *M. arvensis*, *M. xpiperita*, and *Rosmarinus* sp. While doing research, Nast (1972; 1987) reported similar data regarding the species of the genus *Eupteryx*. The highest numbers of *Eupteryx* individuals were found in mother planted fields, from where they were probably transferred to greenhouses together with rosemary seedlings. Only individual specimens were found in the greenhouses. Adult individuals were eliminated from the mother plantings with the aid of a vacuum cleaner. The number adult individuals were also reduced by spraying the plants with natural Pyrethrum obtained from dried and crushed flowers of plants from the family Asteraceae.

Earlier studies had also reported the presence of *T. vulgaris* and *M. officinalis*, auchenorrhynchan species representing the genus *Eupteryx*, in the field (Goszczyński and Cichocka 2004). The insects might fly onto the inspected mother plantings from the field or might be brought to the greenhouses together with culinary herbs.

Auchenorrhynchan insects of the genus *Eupteryx* are an important group of pests from a financial point of view. In Great Britain, the presence of *Eupteryx melissae* Curtis 1837 has been reported in greenhouses on such herb species as: green sage, golden marjoram, lemon basil, and rosemary. As for *Eupteryx aurata* (Linnaeus 1758), it has been found on spearmint (Bennison 2001). Furthermore, Rung *et al.* (2009) have reported large numbers of *Eupteryx decemnotata* Rey 1891 on *Rosmarinus* sp. According to Nickel and Holzinger (2006), host plants of *E. decemnotata* include *S. officinalis*, *Nepeta xfaassenii*, and *Rosmarinus officinalis* L. as well as other species from the Lamiaceae family.

#### Aphids

Aphids constituted the most numerous group of species encountered on the studied plants. The aphids were divided into two groups. The first group included the species that could be found throughout the year in cultivations: *Myzus persicae* Sulzer 1776, *Aphis gossypii* Glover 1877, *Aulacorthum solani* Kaltenbach 1843, and *Ovatus mentharius* (van der Goot 1913). The second group included the species that could be found only periodically, during spring and autumn migrations: *Cavariella aegopodii* (Scopoli 1763), *Dysaphis crataegi* (Kaltenbach 1843), and *Aphis fabae* Scopoli 1763.

In order to reduce the numbers of aphids, the parasitic hymenopteran species *Aphidius colemani* Viereck 1912 was introduced, as well as *Aphidius ervi* Haliday 1834, *Aphidius matricariae* Haliday 1834, and predatory green lacewings of the genus *Chrysopa*. Apart from that, alate female aphids were caught on the yellow sticky boards.

The most frequently recorded species was *M. persicae*. It was found on *E. sativa*, *M. xpiperita*, and *O. basilicum*. Depending on the host plant, *M. persicae* varied with respect to body size and colour, ranging from pale yellow to dark green or even pink. The *M. persicae* aphid species is a polyphage, often encountered in various field and greenhouse cultivations (Blackman and Eastop 2000; 2006; Cichocka 1980; 1998).

The smallest aphid species, *A. gossypii*, was also frequently encountered. It inhabited *Rosmarinus* sp. and *P. crispum* throughout the year. This aphid species is polyphagous, developing in greenhouses all year round. This small aphid species comes in a variety of colours (Blackman and Eastop 2000; 2006; Cichocka 1998). In summer it may leave greenhouses and forage on the Cucurbitaceae, but in the autumn it returns to greenhouse cultivations (Cichocka 1998).

*Aulacorthum solani* settled on the tops of *O. basilicum* and within 10 days was able to form numerous colonies (up to 50 individuals per plant). However, only about 2% of the total number of plants were inhabited by that species and they were instantly removed from the gutters and destroyed. The species is a polyphage and it also hibernates in greenhouses, settling on many plant species (Blackman and Eastop 2006; Cichocka 1998).

*Ovatus mentharius* settled only on *M. xpiperita*, and over a short period of time formed numerous colonies on the plant. This aphid species is classified as holocyclic and monoecious (Szelegiewicz 1968). The species had not been encountered in a greenhouse before, but introducing cultivations of its host plant into greenhouses, seemingly enabled the species to forage throughout the year. Its bionomy was thus changed; no winter eggs and continuous parthenogenetic development. Previously, *O. mentharius* had been recorded on peppermint in field cultivations (Goszczyński and Cichocka 2004). It might possibly fly from the field cultivations with *O. mentharius* to mother plantings and greenhouses.

The mass appearance of *C. aegopodi* on *Anethum graveolens* was observed in May. This was the migration period of this species from willows to plants of the parsley family (Blackman and Eastop 2000). *Cavariella aegopodi* was the only species that was quickly able to settle on 100% of the

dill plants. As long as the aphids were not very numerous, they were brushed off before the herbs were taken away for sale. Those plants inhabited by a high number of insects were destroyed. So far, no other insect species apart from aphids has been encountered on dill. Large numbers of *C. aegopodi* have been encountered on herbs of the parsley family in the fields (Goszczyński 1998) as well as on dill cultivated in gardens (Cichocka 1984).

Similarly to the species discussed above, *D. crataegi* appeared in the spring, during its migration from hawthorns to plants from the parsley family. In the inspected greenhouses it settled on leaf stems of *P. crispum*. It was rarely encountered though, and found only in low numbers.

*Aphis fabae* appeared on *P. crispum* in September and formed comparatively numerous colonies (about 10 individuals per leaf base). However, the total number of plants inhabited by that species did not exceed 1.5%. *Aphis fabae*, like *M. persicae*, is a polyphage and it can be encountered on many cultivated plants in the field, on ornamental plants, and even in orchards (Blackman and Eastop 2000; 2006; Cichocka 1980).

#### Moths

On *M. arvensis*, *M. xpiperita*, and *O. basilicum*, low numbers of the Hadeninae (Noctuidae: Hadeninae) larvae were found in the summer. In every case, several larvae were collected that had bitten out holes at the base of a plant. Adult individuals that invaded the cultivations by flying in, were caught in light traps at night. The Hadeninae are a very numerous moth family (Studziński 1979). Some of their representatives are well-known pests in those greenhouses with tomato cultivations (Napiórkowska-Kowalik and Gawłowska 2009).

In field cultivations of *A. schoenoprasum* (young seedlings), larvae of moths representing the genus *Agrotis* (Noctuidae: Noctuidae) damaged plant bulbs. Adult individuals of those species were also caught in light traps.

#### True flies

Among true flies, representatives of the family Sciaridae were the most common. They were found in the soil in which all of the studied herbs grew. In order to prevent them from appearing in high numbers, the sowing of herbs was accompanied by the introduction of parasitic nematodes of the genus *Steinernema*. At the time when the root system was developing, predatory mites of the genus *Hypoaspis* were added as well. The mites fed on the larva of dark-winged fungus gnats and on the nymphs of thrips.

True flies from the family Sciaridae are either introduced into greenhouses together with substrates (larvae) or the adult individuals fly into the greenhouses during the vegetation period. The larvae feed on the substrate, but when the substrate becomes too dry and when the larvae are too numerous, they damage root collars, roots and sprouts of plants (Szwejdka 2004a, b).

On the algae, which also appeared from time to time, *Scatella stagnalis* from the family Ephydriidae was discovered. Even though the species did not have much significance from the point of view of the monitored cultivations,

its representatives often fell into the eyes of greenhouse staff and caused eye irritations. When they appeared in high numbers and settled on the cultivated plants, they sometimes polluted the leaves with small clods of black faeces. *Scatella stagnalis* is considered a pest of plants cultivated under covers (Dankowska 1998; 2006). According to Dankowska (2006), this fly species achieves its peak of abundance in May.

#### Snails and slugs

On *Rosmarinus* sp. growing in greenhouses, some 3 mm long snail specimens were observed. They crawled over plants and fed on leaves, biting out small holes in them. In mother plantings of *M. xpiperita*, young stages of slugs, not exceeding the size of 1 cm were observed. The slugs gathered at the base of plants and bit out small holes in the plants. Parasitic nematodes *Phasmarhabditis hermaphrodita* (A. Schneider 1859) were introduced in order to combat them. According to common belief, slugs are more harmful than snails. They significantly damage agricultural cultivations, as well as garden cultivations under covers (Kozłowski 2010). Kozłowski (2010) provided a list of domesticated plants on which slugs were likely to settle, but most culinary herbs were not mentioned. The author only pointed out that slugs settled in large numbers on *Petroselinum* sp. and on *A. schoenoprasum*, but on the latter plant species they were less numerous (Kozłowski 2010).

#### CONCLUSIONS

No previous research has been conducted into invertebrates that settled on culinary herbs in greenhouse cultivations. Cultivation of culinary herbs under covers, differs from vegetable cultivations, especially with respect to the length of the period that the plants spend in the greenhouse. Vegetables take many months to grow, whereas in the case of culinary herbs the period of growth is just several weeks long. For this reason, insects do not have time to form abundant populations on the herbs, but their presence still contaminates the herbs. In the case of culinary herbs, practically the whole plant is eaten, not only its fruits. Hence, the presence of even individual invertebrates is undesirable. And in the case of culinary herbs grown for sale, certainly no invertebrates can be tolerated. Obviously, no one is willing to buy herbs with aphids or snails. Infested plants have to be destroyed which results in losses for producers. Despite the implementation of biological methods of pest control, light traps, and vacuum cleaners for catching flying insects, 2% or more of cultivated plants have to be removed from greenhouse gutters and destroyed.

The culinary herbs that turned out to be the most popular with pests were the following: peppermint (representatives of six groups of invertebrates: Thysanoptera, *Eupteryx* sp., *M. persicae*, *O. mentharius*, larvae of Hadeninae, larvae of Sciaridae, Gastropoda), and rosemary (representatives of six groups of invertebrates: Thysanoptera, *Trialeurodes vaporariorum*, *Eupteryx* sp., *A. gossypii*, larvae of Sciaridae, Gastropoda), followed by basil (representatives of four groups of invertebrates: Thysanoptera,

*M. persicae*, *A. solani*, larvae of Hadeninae, larvae of Sciaridae) and parsley (larvae of Sciaridae and three aphid species: *A. gossypii*, *D. crataegi*, *A. fabae*). On the remaining herbs just single invertebrate species were found.

It should be noted, that garden mint was very rarely infested with pests. Even if pests were recorded, just several individual specimens were found. Pests were noted when pots of peppermint were in close proximity to garden mint. Thus, the cultivation of peppermint in the inspected greenhouses was discontinued and only garden mint cultivations were retained.

Out of 16 species of culinary herbs cultivated in the inspected greenhouses, no invertebrates were found on 6 species, namely: *Anthriscus* sp., *C. sativum*, *A. dracunculus*, *O. majorana*, *O. vulgare*, and *S. officinalis*. The most numerous group of pests were the hemipteran insects (Hemiptera), with aphids being the most numerous within the group. But because of the specific character of the studied cultivations (3–8 weeks spent in a greenhouse), representatives of that group did not achieve high numbers and did not settle on more than 10% of plants. The only exception was *C. aegopodii*, which migrated from willows to plants from the parsley family in May and was able to settle on 100% of those plants. Apart from that period, *C. aegopodii* was absent from the monitored greenhouses. We believe that it would be advisable to resign from cultivating dill during May, especially since dill can be harvested from field cultivations in May. Some species of invertebrates are transferred to greenhouses from mother plantings and some fly in from the fields. True flies, snails, and slugs are often brought in together with a substrate.

The only acceptable substance that can be used for reducing the numbers of invertebrates on culinary herb cultivations is natural Pyrethrum. The cultivations can also be protected by using biological pest control which is implemented as well in greenhouse cultivations of vegetables and ornamental plants. An untypical method applied in greenhouses is the use of light traps to catch nocturnal moths such as the Hadeninae. The original method consists in using vacuum cleaners to suck out adult individuals of the Auchenorrhyncha. This method also proved effective in eliminating a small number of alate forms of other hemipteran insects and thrips. Furthermore, yellow sticky boards were hung out in the inspected greenhouses to monitor the appearances of the auchenorrhynchan insects, thrips, whiteflies, aphids, dark-winged fungus gnats, and shore flies.

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