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CHAMAEMYIIDAE (DIPTERA) - PREDATORS OF APHIDS ON TOBACCO

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ABSTRACT

The use of natural enemies is the basic means of biological control of arthropods, vertebrates, weeds and plant pathogens.
Chamaemyiidae, also known as silver flies or silver aphids, are larval predators of Homoptera found in a wide range of cultural plants, trees and weeds.
Observation of silver flies was made during 2010-2012 in the region of Prilep, on 20 tobacco stalks and 100 tobacco leaves.
The collected material was further analysed under laboratory conditions.
During the investigations, the aphidophagous species *Leucopis* sp. (Chamaemyiidae) was determined as predator of *Myzus persicae* Sulz. on tobacco.
Females lay their eggs singly on the underside of tobacco leaves, among the aphid colonies. The larva of this species is considerably greedier during the second, and particularly during the third larval stage. Larvae are transformed into pupae in the same plants on which they feed. Adults are mobile and they are able to locate the prey quickly.
Leucopis sp. survival on *M. persicae* and its quantitative representation was significantly higher in 2011-2012 than 2010. The most massive occurrence of silver flies is recorded in August.
Chamaemyiidae can be used in biological control of aphids, as a part of integrated protection against these pests.

Key words: tobacco, leaf aphids, predator, Chamaemyiidae, *Leucopis* sp.

CHAMAEMYIIDAE (DIPTERA) ПРЕДАТОРИ НА ЛИСНИТЕ ВОШКИ НА ТУТУНОТ

Основа на биолошката контрола на членконогите, ‘рбетниците, плевелите и растителните патогени е употребата на природни непријатели.
Видовите од фамилија Chamaemyiidae се познати како сребрени муви. Ларвите се предатори на Homoptera, кои живеат во широк спектар на културни растенија, дрвја и плевели.
Проучувањата на сребрените муви беа спроведени на тутунот во околината на Прилеп во текот на 2010-2012 година, со примена на следниве методи на ловење: проверка на сите лисја од 20 тутунски страка и проверка на 100 тутунски лисја.
Собраниот материјал беше дополнително одгледуван и анализиран во лабораториски услови.
При истражувањата го детерминиравме афидофагниот вид *Leucopis* sp. (Chamaemyiidae), како предатор на *Myzus persicae* Sulz. на тутунот.
Женката ги полага јајцата поединечно, меѓу колониите од лисните вошки, на долната страна на тутунските листови. Лакомоста на ларвите е зголемена за време на вториот, а посебно во третиот ларвен степен.

Ларвите се куклат, на истите растенија каде што се хранеле. Возрасните се мобилни и може брзо да го лоцираат пленот.
Опстанокот на видот *Leucopis* sp. на *M persicae* и неговата квантитативна застапеност е значително повисока во 2011-2012 година отколку во 2010 година. Најмасовна застапеност на сребрените муви има во август.
Chamaemyiidae може да се користат во биолошка контрола на растителните вошки и во склоп на интегралната заштита против овие штетници.

Клучни зборови: тутун, лисни вошки, предатор, Chamaemyiidae, *Leucopis* sp.

INTRODUCTION

Chamaemyiidae (Diptera) are small cosmopolitan flies. Immature Chamaemyiidae are predators of scale insects, mealybugs and aphids. They are important means of biological pest control.
According to Gaimari and Turner (1996), the family Chamaemyiidae is represented by a small flies (1-4 mm) whose larvae are predators on soft bodied Homoptera.
Adults occur in various grassland habitats, in reeds, in mixed or deciduous forests, in lowlands, but also in montane habitats (Barták and Papp, 2009).
According to Evenhuis (1992), they are recorded as predators of aphids and coccids. Colless and Mcalpine (1991), also recorded them as predators of psyllids.
In Quebec, Canada, silver fly *Leucopis spp.* (Chamaemyiidae: Diptera) larvae are commonly encountered within apple aphid colonies (Fréchette *et al.,* 2008).
Silver fly is the specific host for *H. pruni* that feeds only on *Phragmites spp*. (Rakhshani *et al.,* 2010).
Some species of *Neoleucopis* and *Leucopis* were introduced into North America from Europe, for control of Dreyfusia spruce (Tanasijtshuk, 1997).
Thalji (1988, 1992), obtained Chamaemyiidae as predator of aphids on leaf sunflower in Serbia -Vojvodina.
Our first report of Chamaemyiidae as predator of aphids in Macedonia was in 1996. Silver flies are found within aphid colonies of tobacco in the region of Prilep (Krsteska, 2002).
However, very little is known about the ecology and biology of most of the members of this group.

MATERIAL AND METHODS

Investigations were carried out during 2010-2012, on tobacco plants in the area of Prilep.
The observations of silver flies were made with application of the following methods of catching: check of all leaves from 20 tobacco stalks and check of 100 tobacco leaves (Davies method).. Monitoring and collecting of material from tobacco seedlings was performed during tobacco vegetation, from May until the end of September, at 10-day intervals.
The collected material was further nourished, cultivated and analysed under laboratory conditions.
For research of Chamaemyiidae in laboratory conditions and for investigation of their biology, standard methodology was applied. Adults were fed on a mixture of honey and yeast in cages, while larvae were reared on tobacco leaves infested with *M. persicae* in Petri dishes. Once formed pupae can be put in tubes where the emergence of adults can be easily observed.
Weight of silver flies in various stages of growth was measured on Sartorius BL 210 S analytical balance (d=0.1 mg), while length and width on Carl Zeiss Jena binocular (25 x 5). Body length was measured by adding the length of the head (without antennae) through

the thorax to the abdominal length, to account for differential curling of the abdomens.

RESULTS AND DISCUSSION

The Chamaemyiidae (Diptera) family, commonly known as silver or aphid flies, represents a group of larval predators attacking aphids, adelgids, scales, mealybugs and are thought to be potentially useful as biological agents of these insects.
The Chamaemyiidae family belongs to the kingdom Animalia, subkingdom Eumetazoa, phylum Arthropoda, subphylum Hexapoda, class Insecta, order Diptera, suborder Brachycera, division Muscomorpha, Schizophora, Acalyptratae, superfamily Lauxanioidea.
It is divided into three subfamilies: Chamaemyiinae, Cremifaniinae, Leucopinae.
Although the species of some chamaemyiid genera are quite general in their feeding habits, many genera are restricted to a particular host taxon (Gaimari, 2012). In all years of our investigations silver flies were recorded as predator on *M. persicae* in tobacco fields.
Larvae of silver flies were usually found among colonies of green peach aphid -*M. persicae*. The role they play in the long term regulation of aphid populations can be important, because their larvae are feeding with them.
According to our investigations in the region of Prilep, aphid infestations are inevitable and occur every year, ranging from medium to large. We collected Chamaemyiidae eggs and larvae from tobacco leaves infested with *M. persicae*. The collected material was further nourished, cultivated and analyzed under laboratory conditions.

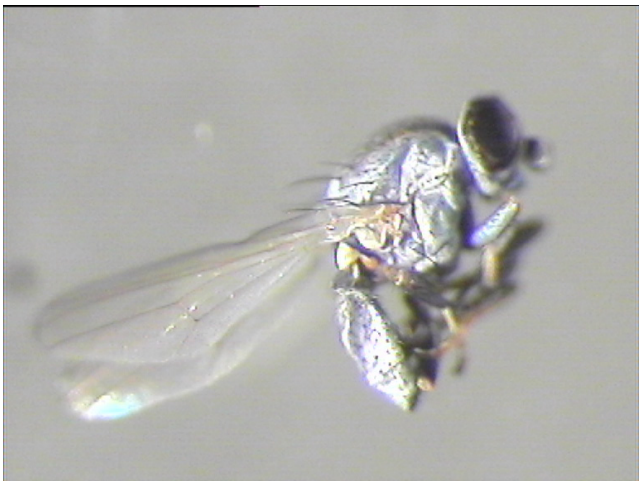


Fig. 1 ***Leucopis sp.***

During investigations we identified the aphidophagous genus *Leucopis* and studied the life history of *Leucopis* sp. (Fig. 1), as an aphid predator on tobacco.
Eggs were laid in or near colonies of the host on the underside of tobacco leaves. They are laid singly among *M. persicae* colonies. Acording to Clausen (1940a), they are laid singly among the egg masses or colonies of the host. Tracewski (1983), observed that *Leucopis* sp. *nr. albipuncta* eggs are usually laid in a group of 2–3 under apple leaves in New Hampshire (cit. Fréchette *et al.,* 2008). According to Ghadiri *et. al.* (2003), the average fecundity was 35.7 eggs.
The eggs are tiny, almost invisible, 0.35-0.38 mm long and are pearly white, with the surface bearing longitudinal ridges. They

have two ends, the first one rounded and the anterior end is a bit pointed. Eggs are usually deposited horizontally on the leaf.
In our investigations, the duration of egg stage was 2.5–3.5 days, similar to the data reported by Clausen (1940a) - 3-4 days. The average incubation period of *Leucopis glyphinivora* Tanas is 2.7 (Ghadiri *et. al.,* 2003).
As the embryo develops, the color of the egg turns from white to brown. By contraction and spreading, larva tears the chorion and then gently slides off the egg shell.
After hatching, the larva is of transparent white color and is still egg-shaped. The larvae are somewhat restricted by their body size, being able only to subdue prey smaller than themselves. First larval instar was exclusively feeding on 1st and 2nd nymphal instars of aphid.
During their growth, a larva shed two times and passes through three larval instars and becomes more and more mobile. The larva is very similar to those of the family Syrphidae, in the transition from the first to the second stage. Larvae vary in rear spiracles: in Syrphidae rear spiracles are found together, and in silver flies they are distributed along the edges of the last segment, more or less protruding.
As the larvae of *Leucopis sp.* grow, the integument is bare, they become larger and they turn reddish (Fig. 2). Larval respiration can be clearly observed through the cuticle. In third larval stage (L3), larvae have the average weight ranging from 4 mg to 6 mg, and the length from 4.5 mm to 5 mm. According to Clausen (1940a), third instar larvae of *Leucopis bella* are 5.00 mm long and clothed only with tiny setae.
Larvae are tapered toward the head, broadest in the abdominal region, and bluntly rounded posteriorly, with caudal spiracles. L3 is dorsally slightly curved and ventrally slightly flattened.

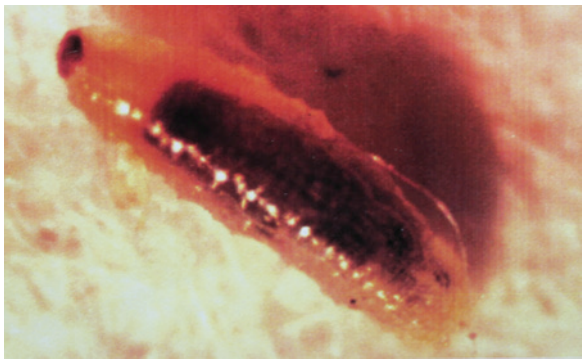


Fig. 2 Larva

They have strong mouth-hooks, suitable for catching the prey, sharp mouthparts like a dagger, strong pharynx and head muscles which help them to stab and suck the prey. Their greed increases during the second, and particularly during the third larval stage.
According to Sandhu and Kaushal (1977), fly larvae are eating 40-60 aphids during their development.
When they hunt aphids they do not disperse them, which provide them constantly with food. During the 3rd instar larvae are more mobile, even move between aphid colonies and plants (Fréchette *et al.,* 2008).
In our investigations the duration of larval stage is 6-7 days, which is less than findings of Sandhu and Kaushal (1977), according to whom this stage lasts 10-12 days. Larvae of *Leucopis verticalis* Malloch complete their development in 12 to 15 days (Sluss and Foote, 1971).
Larvae do not leave excrements frequently, but before pupation. The great quantity of mucilaginous substance darkens quickly and

attaches the puparium to the substratum. The black excrements signalize that some larva in the laboratory or in field was transformed into pupa. In the nature, larvae are transformed into pupae in the same plants on which they feed, among the host: in the underside of tobacco leaves, in leaf sleeve or hidden among flowers and seed capsules (Fig. 3).

In Petri dishes, larvae seek for suitable place for pupation in reverse side of leaves or flowers, in hidden places far from light. Puparium is formed from the last larval skin and its color and patterns resembles of the 3rd stage. Immediately after pupation, the pupa is soft and its inside is still pulsating. Gradually, the skin of the pupae becomes firmer. The puparium is reddish brown, the front part of the pupae is rounded and adults eclode from there. Posterior spiracles of the mature larva persist unchanged.

Fig. 3 Pupa and wrinkled, dark aphids

The average pupal size is 3.5 mm and the average weight is 5.5 mg. In our investigations, duration of pupal stage was 6-7 days. Sandhu and Kaushal (1977) reported pupal duration of 15-20 days. Puparium duration of *Leucopis glyphinivora* Tanas. averaged 8.45 days (Ghadiri *et. al.,* 2003). The pupal period of non-diapausing pupae of *Leucopis verticalis* Malloch. requires about 12 days (Sluss and Foote, 1971).

Before the eclosion of the imago, the pupa becomes darker. As the head of imago presses the puparium, it cracks and the imago comes out of the pupa (Fig. 4 and 5).

Fig. 4 Pupa before eclosion

Adult insects are small, winged, considerably short and silvery grayish, with dark grey spots on the head, thorax and abdomen. The wings are moderately broad, costa is continuous, vein Sc is complete, striking crossveins and wing costal area darkened. The head is almost round and wider than the thorax. The facetae are dark brown. Ocelli are present. Antennas are black, third limb of the antenna is the largest and arista is black and bare. Frons is widened anteriorly, clypeus is small. On mesonotum golden brownish lateral stripes and bristles are present (Fig. 6).

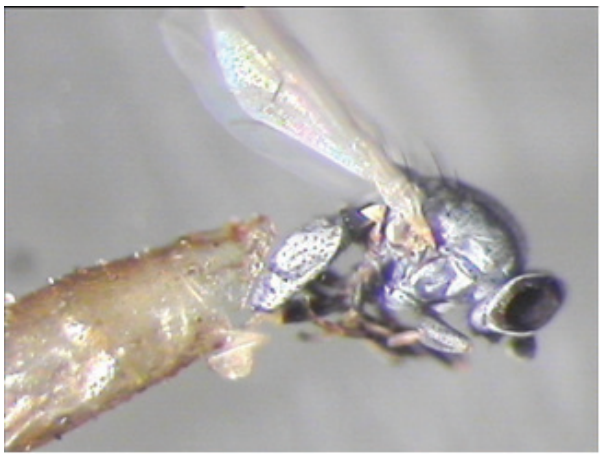


Fig. 5 Eclosion of imago

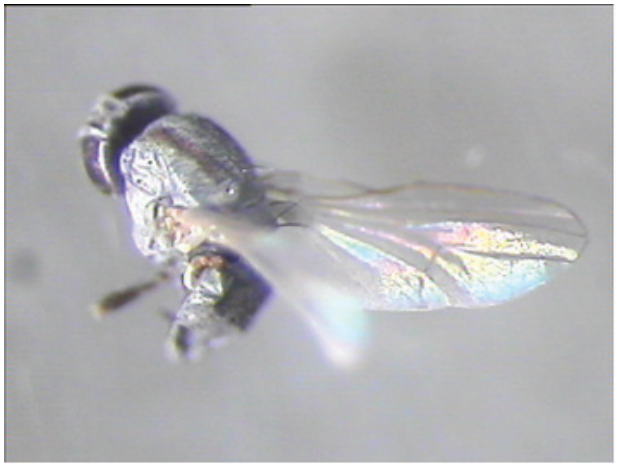


Fig. 6 Golden brownish lateral stripes and bristles on mesonotum

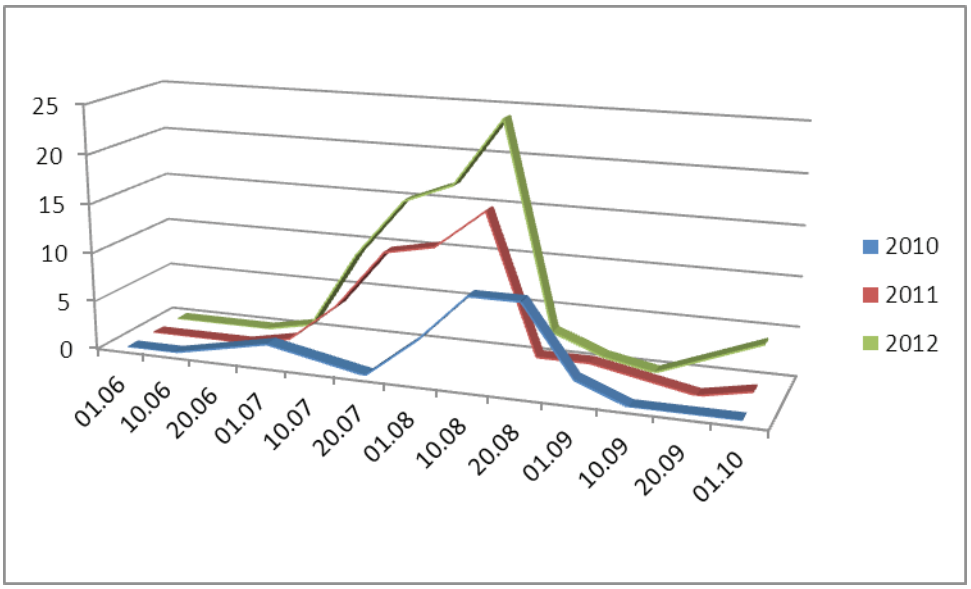
The body is 3 mm long. Scattered small and large bristles and microtrichia are present. Typical for this species is that their body is somewhat curved in the lower part, i.e. the abdomen is curved downward. Legs are black. Femur apices, some part of tibia and tarsus is yellow. Male genitalia are symmetrical. The species is distinguishable using male characteristically genitalia. Female has flexible tubular ovipositor.

In laboratory conditions, the imago lives 6-7 days. Adults are mobile and able to locate the prey. Reproductively mature females will found the prey while looking for oviposition sites.

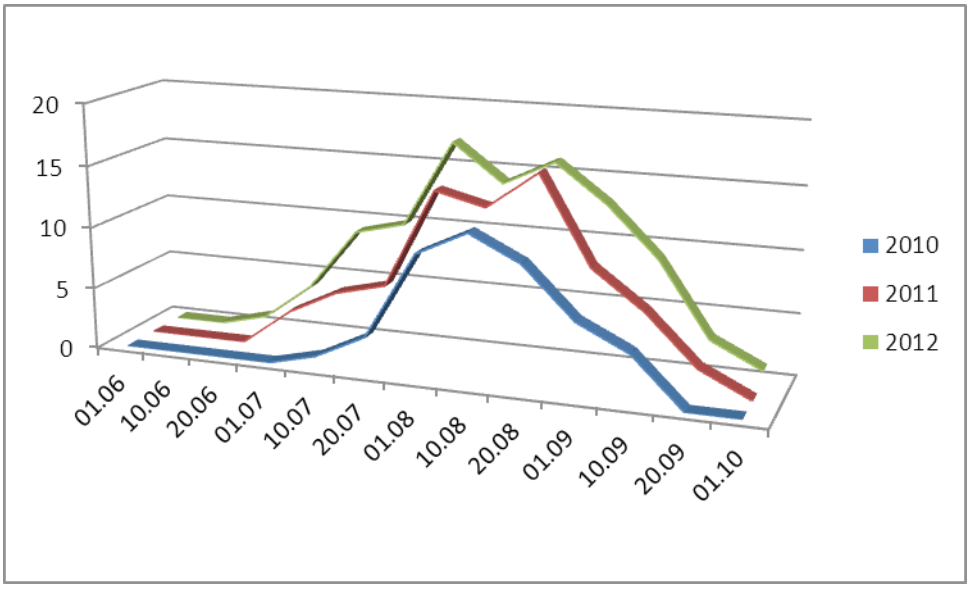
In our investigations, the growth of one generation from egg to imago was 21-24 days. In nature, if no diapause intervenes, the entire life cycle of *Leucopis verticalis* Malloch. can be completed in 33–42 days (Sluss and Foote, 1971). Martelli (1908), reported that the cycle from egg to adult takes 30 days. In temperate regions, over-wintering is occurring as diapausing pupae

(Sluss and Foote, 1971).

Leucopis sp. survival on *M. persicae* and quantitative representation was significantly higher during the 2011-2012 than 2010. Their abundance is highly correlated with aphid density. On graph 1 and 2 are shown the results of quantitative representation of silver flies on tobacco.



Graph 1. Quantitative representation of silver flies on tobacco (method of Davies)



Graph 2. Quantitative representation of silver flies on tobacco (survey of 20 tobacco stalks)

The greatest quantitative representations of Chamaemyiidae are noticed in August.

CONCLUSIONS

The eggs are tiny, almost invisible. The eggs are pearly white, 0.35-0.38 mm long, with longitudinally ribbed surface and with two ends, the first one is rounded and the anterior end is a bit pointed. Duration of the egg stage was 2.5–3.5 days.

After hatching, larva is of transparent white color and is still egg shaped. During its

growth, the larva shed two times, passing through three instars and becoming more and more mobile. As the larvae of *Leucopis* sp. grow, the integument is bare, they become larger and they turn reddish. In the third larval stage (L3), larvae have the average weight ranging from 4 mg to 6 mg and are 4.5 mm to 5 mm long.

Larvae are tapered toward the head, broadest in the abdominal region, and bluntly rounded posteriorly, with caudal spiracles. L3 was dorsally slightly curved and ventrally slightly flattened. Duration of larval stage was 6-7 days.

The puparium is reddish brown, the front part of pupae is rounded and adults eclode from there. Posterior spiracles of the mature larva persist unchanged. The average pupal size was 3.5 mm and the average weight was 5.5 mg. Duration of pupal stage was 6-7 days.

Adult insects are small, winged, considerably short and silvery grayish, with dark grey spots on the head, thorax and abdomen. Scattered small and large bristles and microtrichia are present. The body is 3 mm long. In laboratory conditions, the imago lives 6-7 days.

In our investigations, the growth of one generation from egg to imago was 21-24 days

The role that they have in the long term regulation of aphid populations can be important. They may be used for biological control of aphids and in the scope of integrated pest management against these pests.

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