

The Species of Superfamily *Chalcidoidea* – Parasites of Aphidophagous Hoverflies

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Geliş Tarihi (Received): 01.03.2017

Kabul Tarihi (Accepted): 15.04.2017

The species of the family Syrphidae are one of the most important predators of the peach leaf aphids on tobacco. In the complex food chain, aphidophagous hoverflies are attacked by a wide range of parasites. During tobacco vegetation, in the Prilep area, we applied the following methods: survey of 20 tobacco stalks and survey of 100 tobacco leaves, in 10 days interval, 2003-2005. The prime material collected from the nature, further is cultivated and analysed under laboratory conditions. Parasited larva of Syrphidae, feeds with aphids and perform its bioregulatory role. Parasite species are activated after the larva of hoverflies is transformed into a pupet stage. They are feeding on tissues and organs of the hoverflies and destroy them. Were identified three parasite species from superfamily Chalcidoidea, eclosed from pupae of hoverflies: *Pachyneuron grande* (Pteromalidae), *Pachyneuron* cf. *grande* (Pteromalidae) and *Syrphophagus aeruginosus* (Encyrtidae). The most numerous is the parasitic specie *P. grande*. It was registered as a parasite on: *Sphaerophoria scripta*, *Sphaerophoria rueppelli*, *Episyrphus balteatus*, *Scaeva pyrastris* and *Eupeodes corollae*. *P. cf. grande* is a parasite on: *S. scripta* and *S. rueppelli*. *S. aeruginosus* is a parasite on: *S. scripta*, *S. rueppelli*, *S. pyrastris* and *E. balteatus*. The emergence of parasitic species depends on the occurrence of host-hoverflies, while the emergence and development of aphidophagous hoverflies depends on the occurrence of the peach leaf aphids on tobacco and climate conditions of the area. This study may contribute in strategies of biological control of plant pests and IPM implementation.

Keywords: Aphids, *Syrphidae*, parasites, *Chalcidoidea*

Introduction

Superfamily Chalcidoidea is one of the largest groups of parasitoid wasps within the order Hymenoptera, with several thousand known species, and many others which have yet to be described. They range in size from 0.13 mm to 30 mm, usually under 3 mm. Most of the species are parasitoids or super-parasitoids of other insects. A few species are phytophagous.

Family Pteromalidae includes 588 genera with 3506 species, belonging to 31 subfamilies. These subfamilies also include Pteromalinae, with 314 genera and 2073 species. The life-cycle of the species in this family is variable. There are solitary and gregarious species, ectoparasitoids and endoparasitoids, koinobionts and idiobionts, primary and secondary parasitoids and even predators.

Palaeartic species of the genus *Pachyneuron* (Pteromalidae) were revised from Szelényi (1942), while the European species of the genus *Pachyneuron* were revised by Delucchi (1955 b). Since then some synonyms and nomenclature are changed. Pek (1963), gave a list of 14 species of the

genus *Pachyneuron* in North America (cit. Graham, 1969). According to Cheek et al. (1974), more than 50% of hoverflies are attacked by parasites, one of which is *Pachyneuron* sp.

The *P. grande* species is present in Croatia, Bosnia and Herzegovina, Serbia, Montenegro, Kosovo, Austria, Czech Republic, Hungary, parts of the former USSR, Slovakia, Moldova, France, Germany, Switzerland, Belgium, Sweden, Spain, Argentina, Iran (Graham, 1969; Boucek, 1977). Delucchi (1955), reported that the parasitic species could be found almost everywhere in the north of the Alps. The species has been recorded in Sweden and eastern Switzerland.

The family Encyrtidae currently includes 460 genera and 3735 species placed in 2 subfamilies: Encyrtinae and Tetracneminae. Encyrtinae subfamily includes 353 genera with 2920 species and Tetracneminae subfamily includes 107 genera with 815 species. The Encyrtidae greatest diversity is in tropical and subtropical areas. About half of the Encyrtidae species are associated with scale-insects (Homoptera: Coccoidea), generally as endoparasitoids of immatures or less commonly

adults, but with egg predation practised by some species of Microterys (De Bach, 1939). Almost all species belonging to the Tetracnemiinae are parasitoids of Pseudococcidae, whilst species of Encyrtinae are known to be parasitoids of a wider variety of coccoids (occasionally also of Pseudococcidae) and other insects, mites, ticks and spiders (Tachikawa, 1981).

According to Trjapitzin (1989), there are 77 species of the genus Syrphophagus (Encyrtidae), of which 44 are determined in Palaearctic and 17 species are recorded in parts of the former USSR. According to Trjapitzin (1989), the species of the genus Syrphophagus are hyper-parasites of pupas of hoverflies and sometimes Lonchaeidae (Diptera), and also they are hyper-parasites of aphids (Homoptera, Aphidoidea) and jumping plant lice (Homoptera, Psylloidea).

S. aeruginosus is determined in Serbia, Montenegro, Kosovo, Vojvodina, Macedonia, Croatia, Bulgaria, Austria, Czech Republic, Armenia, Moldova, Romania, Slovakia, Ukraine, Hungary, parts of the former USSR, France, Switzerland, Germany, UK, Madeira, India, Azerbaijan, Armenia, Georgia, the Asian part of Turkey, Lebanon, Syria, Israel, Jordan, Iran, Iraq, the Sinai Peninsula (Egypt), Arabian Peninsula (Boucek, 1977; Trjapitzin, 1978).

Materials and Methods

Field research

For realization of our goals the following methods were applied:

a. Method of survey of 20 randomly selected tobacco stalks infested with aphids. Tobacco stalks were sampled from the whole area of the trial at 10-days interval, starting from June 1, up to the end of September. The tests were performed on targets tobacco (leaves, tobacco flower and flower seed capsules). 10 checks were made by this method in each of the three years of investigations, i.e. 200 stalks per year, or 600 stalks in total. 5813 tobacco leaves were examined in 2003, 5851 in 2004 and 5944 in 2005 or 17608 tobacco leaves in total.

b. Method of Davies- survey of 100 randomly selected tobacco leaves infested with aphids. Tobacco leaves were sampled from the whole area of the trial at 10-days interval, during vegetation. 10 checks were made by this method in each of the

three years of investigations, i.e. 1000 leaves per year, or 3000 leaves in total.

These two methods of analyses are simple and secure to be performed; the advantage of this method is that the data can be collected by one person only.

Laboratory research

The prime material is collected in the nature, after which it is further nourished, cultivated and analysed under laboratory conditions. The eggs, larvae and pupae of Syrphidae, are placed in special containers and raised until adult ecloses. Larvae were reared on tobacco leaves infested with *M. persicae* in Petri- dishes. The pupae which were brought up and those collected were separately placed in test-tubes. Later we have monitored the internal modifications of the pupae, the length of its developing stadium, the degree of eclosion of imago, the percentage of parasitism and the eclosion of different types of parasites.

Among eclosed parasites derived from the Syrphidae, we have determined their species and their morphological characteristics.

Results and Discussion

During laboratory analyzes we have identified three species of parasites of order Hymenopterae, suborder Apocrita, superfamily Chalcidoidea eclosed from the pupae of the aphidophagous Syrphidae: -from the Pteromalidae family, subfamily Pteromalinae, genus *Pachyneuron* Walker (1833) we have detected *Pachyneuron grande* Thomson (1878) and *Pachyneuron cf. grande* Thomson (1878), -from Encyrtidae family, subfamily Encyrtinae, genus *Syrphophagus* Ashmead, (1900): *Syrphophagus aeruginosus* Dalman (1820).

In investigation of parasitic species of the family Syrphidae, according to Jankowska (2004), similarity was found between two species: *P. grande* and *S. aeruginosus*. Harizanov, Babrikova (1990), identified seven species of hoverflies parasites in Bulgaria, including *P. grande* and *S. aeruginosus*, they were also included in our investigations. According to Adashkevich (1975), more than 28 species of syrphid parasites have been observed in the USSR, including *S. aeruginosus* and *P. grande*. Resende et al. (2006) also listed *Pachyneuron sp.* and *Syrphophagus sp.* as parasites of aphidophagous hoverflies.

We should have in consideration that aphidophagous larva still feeds with aphids and perform its bioregulatory role in the destruction of aphids. Parasite species are activated after the larva of hoverflies is transformed into a pupet stage. They destroy the host-hoverfly. In the beginning the pupa of the hoverfly has its specific larval color. Few days later its color becomes more whitish and dull.

According to Krüger (1926), larvae of *S. pyrastris* are often attacked by the parasites and they can be recognized by their pale color.

If you carefully cut the hoverfly pupa, inside you will notice a few small white larvae of the parasitic specie. Then the pupa turns dark and it is a sign of a parasitism.

Whether it is *P. grande*, *P. cf. grande* or *S. aeruginosus*, in the parasited pupa of hoverfly were developed larger number of parasites. When the adults of parasite eclode, they make many holes through the thick cuticle of the hoverfly pupa, on all sides of the pupa. The pupa usually looks like a grid.

Pachyneuron grande Thomson, 1878 is a widespread species of parasite, ecloded from the Syrphidae pupae. During investigations 2003-2005 in tobacco biocenosis in Prilep, *P. grande* was identified as a parasite on the aphidophagous hoverflies *S. scripta*, *S. rueppelli*, *E. balteatus*, *S. pyrastris* and *E. corollae*.

In Macedonia, this species was first identified by Hoffer (1970 d), in Struga and Popova Sapka (cit. Boucek, 1977). According to this author, *P. grande* is found in the forest zone of Europe. According to Jankowska (2004), Pteromalidae family was represented by *P. grande* and this species was responsible for parasitism on 29 species of hoverflies. *P. grande* was described by Evenhuis (1966), Malinowska (1973) and Wnuk (1974), as a parasite of hoverflies (cit. Jankowska, 2004).

In our investigations *P. grande* was registered on 5 hoverfly species. It was found in large number on

S. scripta, *S. rueppelli* and *E. balteatus* pupae in 2003-2005. While in 2004, individual parasitised pupae were identified on *S. pyrastris* and *E. corollae*. Feraru et al. (2004) reported that the parasite *P. grande* emerged from the pupae of *E. balteatus*. In France, according to Delucchi (1953 b), *P. grande* is recorded as a parasite of *E. balteata* (cit. Graham, 1969).

After the hoverfly will reach the pupation stage, the parasite *P. grande* emerges in 12.1 days in *S. scripta*, 12.4 days in *S. rueppelli*, 10 days in *E. balteatus* and *S. pyrastris* and 11 days in *E. corollae*. During investigations we found that 1 - 20 parasites, or in average seven parasites, ecloded from one parasitised pupa of *P. grande*. According to Jankowska (2004), from 3 to 34 imagos of *P. grande* (females and males) emerge from the hoverfly pupae, while Resende et al. (2006), reported that the number of emerged *Pachyneuron sp* imagos is 7 – 11.

In tobacco fields, appearance of parasitised larvae was first determined on the 10th of August. They were most frequently recorded from 25th August to 15th September and then their number gradually decreased. Highest number of parasitised individuals was recorded from 20th August to 10th September and it accounts for 55.26% of the total parasitism of this species. During our investigations, the earliest registered pupae parasitised with *P. grande* was the pupae of *S. rueppelli*, on 22.07.2004, and the last one was that of *S. scripta* and *S. rueppelli*, on 30.09.2003. From studies of Graham (1969), *P. grande* is found from July to September. According to Delucchi (1955) adults of this species are determined from June to July.

The imagos are small, considerably short. The length of females varies from 2.3 to 3 mm. Males are somewhat smaller than females, with a length of 2 to 2.5 mm. Body color of females is green and the thorax is bronze. The body of the males is green to bluish green.



Figure 1. *P. grande* ♀ (dorsal view)



Figure 2. *P. grande* ♂ (dorsal view)

Head is wider than its length, with big complex eyes, antennae are brighter and a little hairy, inserted above the ventral edge of the eyes. The propodeum is dotted, with weak irregular hairs. Hanging stomach is approximately half the length of the propodeum, just slightly longer than its width, slightly narrowed in front and dorsal part is obliquely underlined. The abdomen is shorter than the thorax and seen from above it is flat. The stomach is rounded the first abdominal tergum occupies 1/3 to 1/2 of the abdomen length. In females the abdomen is oval, while in males it is narrower. The wing nervature is rather simple, costal forewing cells are with a row of hairs extending from the distal third to half of the wings. The female legs are brown and tarsus and femur

are darker, sometimes with greenish shade. In males the legs are yellow, except the tarsus.

Pachyneuron cf. grande Thomson, 1878 is a polyphagous parasite and in our investigations it was identified in 2003 as a parasite of two hoverfly species: *S. scripta* and *S. rueppelli*. *Pachyneuron cf. grande* is very similar to the previous species, but they differ in their marginal nerve. Development of the parasite from pupation until eclosion lasts 10 to 12 days. During investigations we found that minimum 1 to maximum 10 parasites of *P. cf. grande* eclose from the parasitised pupa, i.e. in average four parasites. The first occurrence of parasitised larvae was recorded in August 10 and parasitism could be observed until September 18.

was represented by *S. aeruginosus* as a parasite of hoverfly pupae. The species was described by Scott (1939), Malinowska (1973), Wnuk (1974), as a parasite of hoverflies (cit. Jankowska, 2004).

During investigations 2003-2005, in tobacco biocenosis in Prilep, *S. aeruginosus* was identified as a parasite of *S. scripta* and *S. rueppelli* in 2003 and *S. pyrastris* and *E. balteatus* in 2004. In 2005 no parasitized individuals of this species were identified. According to Adashkevich (1975), the parasite *S. aeruginosus* eclosed from the pupae of *S. rueppelli*, *M. corollae*, *S. pyrastris* and *S. balteatus*. In Leningrad area, *S. aeruginosus* was obtained by Talickiy (1966 a), from the pupae of *E. corollae* and in Moldova it was marked as a parasite of *E. balteatus* and *S. ribesii* (cit. Trapicin, 1989). In Serbia (Belgrade) according to Vukasovic (1926 d, 1928 d), the species was found on *Syrphus sp.* and *Paragus sp.* (cit. Bouček, 1977).



Figure 3. *Pachyneuron cf. Grande*

Syrphophagus aeruginosus Dalman, 1820 is a widespread parasite eclosed from the *Syrphidae* pupae. *S. aeruginosus* is polyphagous species and during our trials it was registered as a parasite of four hoverflies species: *S. scripta*, *S. rueppelli*, *S. pyrastris* and *E. balteatus*.

In Macedonia it was first identified by Hoffer (1970 d), in Struga and Popova Sapka (cit. Bouček, 1977). According to Bouček, *S. aeruginosus* is distributed in Palearctic, as a parasite of aphidophagous hoverfly pupae. According to Jankowska (2004), Encyrtidae family

Development of the parasite from pupation of the host until eclosion lasts 12 days. We determined that 15 to 31 imagos of *S. aeruginosus* eclosed from one parasitised pupa. According to Jankowska (2004), 17 imagos emerge from hoverfly pupae of

S. aeruginosus, while Resende et al. (2006), reported 7 to 11 imagos from the pupae of *Syrphophagus* sp.

During tobacco vegetation, the parasitised larvae emerged from 15th August to 15th September.



Figure 4. *S. aeruginosus* ♀ (side view)



Figure 5. *S. aeruginosus* ♂ (dorsal view)

The length of females of *S. aeruginosus* varies from 1 to 1.6 mm and of the males from 1 to 1.4 mm. The average length of imagos is 1.4 mm. The imago body color is black, with dark green reflection. Head is wider than its length, with complex, large eyes; antennae are inserted near oral margin. The width of the vertex is about 1/3 of the maximum width of the head. Both sexes have very elongated mesopleuron, which often takes up more than half of the thorax from side view. Abdomen is shorter than thorax; ovipositor is hidden. Hips of the second pair of legs are placed in the middle level of the mesopleuron. The yellow part of the rear tibia is clearly expressed. The wings are with very simplified veins.

Conclusions

P. grande is polyphagous parasite and during our trials it was registered on five hoverflies species: *S. scripta*, *S. rueppelli*, *E. balteatus*, *S. pyrastris* and *E. corollae*. After hoverfly will reach the pupation stage, the parasite *P. grande* emerges in 12.1 days in *S. scripta*, 12.4 days in *S. rueppelli*, 10 days in *E. balteatus* and *S. pyrastris* and 11 days in *E. corollae*. During investigations we found that minimum 1 to maximum 20 parasites, or in average seven parasites, eclosed from one parasitised pupa of *P. grande*.

During our investigations, *Pachyneuron cf. grande* was registered as a parasite of *S. scripta* and *S. rueppelli*. After hoverfly will reach the pupation stage, development of the parasite from pupation until eclosion lasts 10 to 12 days. In our investigations we found that minimum 1 to

maximum 10 parasites of *P. cf. grande* eclosed from the parasitised pupa, i.e. in average four parasites

S. aeruginosus is polyphagous species and during our trials it was registered as a parasite of four hoverflies species: *S. scripta*, *S. rueppelli*, *S. pyrastris* and *E. balteatus*. Development of the parasite from pupation of the host until eclosion lasts 12 days. We determined that 15 to 31 imagos of *S. aeruginosus* eclosed from one parasitised pupa.

The occurrence of parasite depends on the occurrence of host-hoverflies, while the occurrence and development of aphidophagous hoverflies depends on the appearance of green peach aphid on tobacco and climate conditions in the region of Prilep.

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