

MORPHOLOGY AND BIOLOGY OF PARAGUS QUADRIFASCIATUS

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ABSTRACT

P. quadrifasciatus is an obligate aphidophagous species and it has an important role in biological control of aphids in natural agroecosystems. In all years of our investigations it was recorded as predator on *M. persicae* in tobacco fields. This species is among the smallest syrphid flies. The imagos considerably short and dark. The abdomen is black and its first and second segment are also black. The other abdominal segments have visible yellow-white lateral stripes. In laboratory conditions the adults live 6 - 7 days. Females lay their eggs singly on the underside of tobacco leaves, among the aphid colonies. Eggs are ovate, cream-colored, 0.5 - 0.6 mm long. The embryonic development lasts 3 days. Immediately after hatching, larvae are almost colorless to light beige, with denticulate body. Later, the color turns to brown, with expressed thorns on the segments.

Larvae kill a great number of aphids. Their greed increases during the second, and particularly during the third larval stage. Their larval stage average lasts 8 days. Pupae are yellowish-brown and prickly and the duration of pupal stage is about 5-7 days. According to our investigations, the growth of one generation from egg to imago was 16-19 days.

Key words: *Surphid flies, Paragus quadrifasciatus, aphids, M. persicae*

МОРФОЛОГИЈА И БИОЛОГИЈА НА PARAGUS QUADRIFASCIATUS

P. quadrifasciatus е облигатен афидофаген вид и има значајна улога во биолошката контрола на лисните вошки во природните агрокосистеми.

Во сите години од нашите испитувања овој вид е утврден како предатор на лисната вошка *M. persicae* на тутунот. Овој вид спаѓа меѓу најмалите осолски муви. Имагата се кратки и со темна боја. Абдоменот е црн. Првиот и вториот stomачен сегмент се исто така црни. На останатите сегменти од стомакот видливи се две поизразени, жолто-бели, попречни пруги. Во лабораториски услови имагата живеат 6-7 дена. Женките ги несаат јајцата поединечно, на опачината од тутунските листови меѓу колониите на лисните вошки. Јајцата се овални, со крембова боја, со должина од 0,5 до 0,6 mm. Ембрионалниот развој се одвива за 3 дена. Штотуку испилената ларва е скоро безбојна до светлобежова, назабена по површината на телото. Со текот на развитокот ларвата добива кафења боја, со изразени боцки на сегментите. Ларвите уништуваат голем број на вошки. Лакомоста е зголемена за време на вториот степен, а посебно во третиот ларвен степен. Стадиумот ларва просечно се одвива за 8 дена. Куклите се жолтеникавокафени и боцкави. Стадиумот кукла се одвива за 5 до 7 дена. Според нашите проучувања, развитокот на една генерација од јајце до имаго се одвива во период од 16 до 19 дена.

Клучни зборови: осилки муви *Paragus quadrifasciatus*, лисни вошки *M. persicae*

INTRODUCTION

Paragus quadrifasciatus Meigen, 1822 is an obligate aphidophagous species which develops normally only when fed on aphids.

According to many authors, this species feeds on a wide spectrum of aphids and presents

an important factor in biological control of these pests. Januseska (2001)/Krsteska (2007) reported it as a predator of *Myzus persicae* Sulz. on tobacco.

MATERIAL AND METHODS

Investigations were carried out during 2003-2005, with application of the following methods of catching: check of 20 tobacco stalks; check of 100 tobacco leaves (Davies method); yellow water vessels and mowing with catcher.

For research of hoverflies in laboratory conditions and for investigation of their biology, standard methodology was applied. Larvae were

fed only on *M. persicae*.

Field collected material was analysed in the laboratories of Tobacco Institute on binocular.

Weight of hoverflies 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).

RESULTS AND DISCUSSION

Paragus quadrifasciatus Meigen, 1822

Genus *Paragus* consists of the smallest hoverflies species.

Imagos of *P. quadrifasciatus* are adapted to thermophilic and xerophilic conditions, which is related to their Mediterranean origin.

During our investigations, imagos were recorded from August 10 to September 1.

P. quadrifasciatus was recorded in the hedges of tobacco fields, near the meadows, vegetable gardens and cereal crops.

According to Simic (1987) and Glumac (1955), imagos appear from April to August and Gao (1991) reported their appearance from late April, early May and late August to the beginning of September. This species occurs between the aphids in cereal fields, vegetable gardens or in the thick grass.

Females lay their eggs singly on the underside of tobacco leaves, among the aphid colonies.

The eggs are tiny, almost invisible, but as observation progresses, they can be easily seen with naked eye.

Eggs are ovate, cream-colored, 0.5 - 0.6 mm long, with one end rounded and one end

sharpened. The outer side of the egg is slightly curved. Eggs are usually deposited horizontally on the leaf. They are seldom found in vertical position, with their micropyle upright.

In our investigations the duration of the egg stage was three days.

According to Gao (1991), the duration of the egg stage at 20°C is three to four days. Ma et al. (1986) also reported 3-4 days duration of the egg stage in June and July.

By contraction and spreading, larva tears the chorion and then gently slides off the egg shell.

If not disturbed after hatching, larvae rest in the same place close to the chorion, which is of transparent white color and is still shaped like an egg.

Immediately after hatching, larvae are almost colorless to light beige, with denticulate body. Later, the color turns to brown.

During their growth, larvae shed two times and pass through three stages.

In the first larval stage (L1), the average weight is 1.49 mg (minimum recorded weight 0.4 mg/ maximum 2.1 mg), the average length 3.2 mm (min. 0.9 mm / max. 4.5 mm) and the average width 0.69 mm (Photo 1).



Photo 1. Larva after hatching

As the larvae grows, they become larger and in the second larval stage (L2) they turn brown, with expressed thorns on the segments.

In the second larval stage (L2), the average recorded weight is 5.1 mg (4.5 to 5.9 mg), the average length 5 mm (4 to 5.7 mm) and the average width 1.2 mm.

Toward its mouthpart the larva is pointed, dorsally slightly curved and ventrally flattened, with a pair of expressed, short brown stigmatic tubes.

In third larval stage (L3), larvae are yellow-brown or dark brown, with relatively long thorns along their body. Longitudinal stripe extends through the center of the dorsal side of the body. Larval respiration can be clearly observed through the cuticle. 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.

The average weight of larvae in L3 is 9.4 mg (ranging from 6.5 mg to 12 mg) and the average length is 7.01 mm (from 6 to 7.63 mm).

According to Ma et al. (1986), larval body is 6-7 mm long.

The width of larvae in L3 varies between 1.9 and 2.4 mm.

Larvae kill a great number of aphids. Their greed increases during the second, and particularly during the third larval stage.

When it finds an aphid, the larva stabs it from the outside or the inside and starts to feed on it. The aphid still moves its legs reflexively, while the larva with its mouthpart is penetrating

its body, sucking all its content. Finally, the larva throws the wrinkled and dark aphid away.

The larvae move very fast, always touching the substrate with their heads and excreting secretes. With their sputum they moist the surface on which they crawl and fasten to tobacco plants.

When hungry, the larva sucks the first aphids completely and as it becomes satiated, it doesn't eat it thoroughly, but goes to find another aphid.

In our investigations the duration of larval stage is 8 days. According to Ma et al (1986) duration of larval stage is 7 to 8 days and according to Gao (1991) it is 10 days.

In 2003 and 2005, *P. quadrifasciatus* larvae were recorded in our tobacco fields in August and early September and the maximum was reached in August 20. In 2004, we observed single larvae from the second decade of July to the first decade of September.

According to Gao (1991), larvae can appear among aphids in the thick grass from late May to early September.

Larvae do not leave excrements frequently, but only before pupation. The excrements are black and they signalize that some larva in the laboratory or in field was transformed into pupa.

Larvae of *P. quadrifasciatus* are transformed into pupae in the same plants on which they feed: in the upside of tobacco leaves, in leaf sleeve or hidden among flowers and seed capsules.

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 pattern resemble the 3rd stage. Immediately after pupation, the pupa is soft and its inside is still pulsating. Gradually, the skin of the pupae become firmer. They are yellow-brown and thorny. The rear part is slightly curved inwards and they use it to fasten to the

substrate. The front part of the pupae is rounded and adults eclode from there.

The average pupal size is 5.04 mm (4.8 - 5.6 mm) in length and 1.93 mm (1.7 - 2.2 mm) in width, and the average weight is 8.93 mg (6 to 11.7 mg).

According to Ma et al. (1986), pupae are dark yellow, about 5 mm long (Photo 2).



Photo 2. Pupa

In our investigations, duration of pupal stage was 5-7 days. Gao (1991) reported a duration of 7-8 days, and Ma et al (1986) 12 days.

In tobacco fields, pupae were most frequently recorded in August and early September.

Before the eclosion of imago, the pupa becomes darker. In our investigations it could be stated that eclosion takes place early in the morning. As the head of imago presses the puparium, it cracks in a form of circle and its upper part opens like a lid. The imago comes out of the pupa and stands still.

Immediately after eclosion, the cuticle of the imago is very soft and delicate, but gradually it becomes firmer. In the beginning, wings are shaped like small triangles but gradually they open, stretch and dry. The wings are delicate and soft and their nervature is clearly recognizable. The patterns and color of the body develop in few hours. After eclosion, the abdomen is empty, but it gradually obtains its form.

This species is among the smallest syrphid flies. The imagos are small, considerably short and dark. The head is round and wider than the thorax. The complex eye is dark brown. As in other hoverflies, sexual dimorphism is present,

but the gender can be easily differentiated. The eyes in females are separated and in males they are merged or very close together.

The antenna is brown and its III segment is 2.5 times longer than the sum of the first and second segment. The mesotergum is dark blue, with metallic shine. There is a pair of short longitudinal stripes in the first half and yellow-brown hairs on both sides. Scutelum is black in the first half and yellow in the second. The foot is yellow-brown.

The abdomen is black and its first and second segment are also black. The other abdominal segments have visible yellow-white lateral stripes. The stripes on the last two segments are narrower and interrupted in the middle.

Typical for this species is that its body is somewhat curved in the lower part, i.e. the abdomen is curved downward.

The average length of females is 5.43 mm, varying from 4.5 to 6.7 mm and the width varies from 2 mm to 2.5 mm (Photo 3).

Males are somewhat smaller than females, with a length of 4.5 mm and width 1.7 - 2 mm (Photo 4).



Photo 3. Female of *P. quadrifasciatus*



Photo 4. Male of *P. quadrifasciatus*

According to Bankowska (1963), the imago of *P. quadrifasciatus* is 6 mm long, while according to Ma et al. (1986) its length is 5 - 6 mm.

In our laboratory investigations of the imagos of *P. quadrifasciatus* some deviations were recorded in abdomen color and the abdominal pattern of the adults was incomplete. This was also observed in our field investigations. It was confirmed, however, that it was the same species.

In laboratory conditions, the imago lives 6-7 days.

Sexual index in the investigated years (2003-2005) was 0.54, which indicates that females are somewhat more numerous than males.

In our investigations, the growth of one generation from egg to imago was 16-19 days, Ma et al. (1986) reported a period of 17 - 20 days and Gao (1991) 25-30 days.

CONCLUSION

P. quadrifasciatus is among the smallest syrphid flies. Its larvae are known predators of leaf aphids.

The imagos are small, considerably short and dark. The abdomen is black and its first and second segment are also black. The other segments of the abdomen have two visible yellow-white lateral stripes. The stripes in the last two segments are narrower and interrupted in the middle. Typical for this species is that its body is somewhat curved in the lower part.

The eggs are oval and cream-colored. Duration of egg stage is approximately 3 days.

Immediately after hatching the larva is almost colorless to light beige, with toothed

surface. As the larva grows, it becomes brown, with expressed thorns on the segments. The larval stage usually lasts 8 days.

Pupae are yellowish-brown and prickly and the duration of pupal stage is about 5-7 days.

In laboratory conditions imago stage lasts 6 -7 days.

Sexual index in the investigated years (2003-2005) was 0.54, which indicates that females are somewhat more numerous than males.

According to our investigations, the growth of one generation from egg to imago was 16-19 days.

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