UDC 633.71
Тутун/Tobacco, Vol.61, N^{o} 1-6, 31-40, 2011
University "St. Kliment Ohridski" - Bitola
Scientific Tobacco Institute – Prilep, R. Macedonia

ISSN 0494-3244

UDC: 595.773.1:633.71-265.752
632.937.1:633.71-265.752
Original scientific paper

FAUNISTIC AND QUANTITATIVE ANALYSIS OF SPECIES OF THE GENUS PARAGUS

Vesna Krsteska

University"St.Kliment Ohridski"-Bitola, Scientific tobacco institute-Prilep
Kicevska bb, 7500 Prilep. Republic of Macedonia. e-mail: vkrsteska@yahoo.com

ABSTRACT

Larvae of the aphidophagous species of hoverflies play a significant role in regulation of the number of aphids on tobacco leaf.

During the three-year investigations, we determined the following species of the genus Paragus: *P. quadrifasciatus, P. tibialis and P. testaceus*.

The abundance of predatory species of the genus Paragus primarily depends on the abundance of leaf aphids, but since they are xerophytic and thermophilic organisms, climate factors play an important role in their development.

Key words: aphids, aphidophagous hoverflies, *P. quadrifasciatus, P. tibialis, P. testaceus*.

ФАУНИСТИЧКА И КВАНТИТАТИВНА АНАЛИЗА НА ВИДОВИТЕ ОД РОДОТ *PARAGUS*

Ларвите на афидофагните видови на осилки муви имаат големо значење за регулирање на бројноста на лисните вошки на тутунот.

При тригодишните испитувања ги утврдивме следните видови од родот *Paragus: P. quadrifasciatus, P. tibialis* і *P. testaceus.*

Бројноста на предаторски видови од родот Paragus е во зависност од бројноста на лисните вошки, но како жители на ксерофилни и термофилни услови, значајна улога за нивниот развој имаат и климатските фактори.

Клучни зборови: вошки, афидофагни осилики муви, *P. quadrifasciatus, P. tibialis, P. testaceus*

INTRODUCTION

Faunistic investigations are used in many scientific disciplines with a final aim to conceive the basic ecological, bio-geographical and evolutional principles.

Hoverflies are important predatory species. In their adult stage they are useful as pollinators and in larval stage as natural enemies of pests, especially of aphids.

Genus Paragus is a common and widely spread predator species.

MATERIAL AND METHOD

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

Material was sampled during the season of tobacco growing, from transplanting to the last harvest, in a period of 10 days.

During investigations, detailed quantitative analysis of the genus Paragus was made in the region of Prilep.

Based on the selected material, faunistic investigations were made using the following parameters: active dominance, active abundance, constancy or frequency and population dynamics. For estimation of the number of male and female individuals, Si gender indices were determined.

RESULTS AND DISCUSSIONS

We determined three hoverflies species of the genus Paragus in tobacco agrobiocenosis, belonging to:

Tribus: **Paragini**

Genus: **Paragus Latreille, 1804**

Species: 1. ***Paragus quadrifasciatus* Meigen, 1822**

2. ***Paragus testaceus (bicolor)* Meigen, 1822**

3. ***Pandasyophthalmus (Paragus) tibialis* Fallen, 1817**

Species of this genus are the smallest predator hoverflies. Their larvae are aphidophagous and imagos are adapted to thermophillic and xserophitic conditions, which can be related to their Mediterranean origin. According to Pek (1971), only the species of this genus prefer the plants growing in dry areas.

Paragus is mostly distributed in Mediterranean region, where the number of aphids and aphidophagous hoverflies is small, because most of them dwell in colder and more humid conditions.

Glumac (1965, cit. by Vujic, 1987) reported that conditions of the Mediterranean region are most favorable for hoverflies with small dimensions, which feed on small number of aphids, like the species of this genus.

Identification of Paragus should be made with special carefulness, because of the absence of key which will include all European species.

Stuckenberg (1954) created a subgenus Pandasyophthalamus to which *P. tibialis* belongs (cit. Dusek Láska, 1967).

Vujic (1987) reported that from 20 species of this genus, 10 were found in former Yugoslavia and in Bulgaria, with high population densities.

1. *Paragus quadrifasciatus* Meigen, 1822

P. quadrifasciatus is one of the smallest hoverflies. Its larvae are well known predators of leaf aphids.

According to Simic (1987) and Glumac (1955), this species is spread throughout the Central and South Europe, whereas Vujic, Glumac (1994) report about its spreading in Palearctic area.

On the Balkans the species was recorded in Serbia, Dalmatia, Bosnia and Herzegovina, Montenegro and Bulgaria (Simic 1987, Glumac 1955, Vujic, Glumac 1994). All specimens are typical for the variety *quadrifasciatus* Meig.

In Macedonia, Janusevska (2001) reported *P. quadrifasciatus* as predator of *Myzus persicae* Sulzer on tobacco in the region of Prilep.

Krpac (2006) recorded this species in the regions of Otesevo and Veles.

Photo. 1 Male and female of *P. quadrifsaciatus*

Distribution of *P. quadrifasciatus* in the region of Prilep was determined by the method of mowing with catcher (2003 - 2005). The species was recorded in tobacco fields hedges, near meadows, in vegetable gardens and in cereal crops.

P. quadrifasciatus density is higher in multiculture than in monoculture fields (Gao, 1996). It can be found in high abundance in soybean fields and near water resources (cit. Wu et al.,

In our investigations, imagos of *P. quadrifasciatus* in individual samples were recorded from 1 August to 1 September. Simic (1987) and Glumac (1955) recorded the imagos from April until August. Gao (1991) reported that imagos appear by the end of April to the beginning of May. From late August to early September *P. quadrifasciatus* reappears among the aphids in wheat fields, vegetable gardens or in dense grass.

2004). It was also reported that *P. quadrifasciatus* is more abundant in weeds than in cultivated crops.

Adults feed on flowers of the weed species Apiaceae, Euphorbiaceae, Brassicaceae. etc. They prefer flowers with simple anatomy where pollen and nectar are easily accessible. They are particularly attracted by white and yellow flowers.

P. quadrifasciatus is an obligate aphidophagous species, which means that it develops normally only when fed on leaf aphids.

In our investigations, this species was identified as predator of *M. persicae* on tobacco.

2. *Paragus testaceus* Meigen, 1822 (var. *bicolor* Fabricus, 1794)

P. testaceus is aphidophagous species and belongs to the group of the smallest hoverflies.

Glumac (1955) reported that this species is distributed in Europe, North America and Africa.

According to Simic (1987) and Vujic, Glumac (1994), the species is spread in the Holarctic area.

On the Balkan Peninsula, *P. testaceus* was recorded in all parts of former Yugoslavia, as well as in Bulgaria and Greece (Simic 1987, Vujic, Glumac 1994, Glumac 1955).

According to Krpac (2006), there are very few data on the occurrence of this species in Macedonia. Simic (1987) and Glumac (1994) noted that the flying period of imagos is from April to September.

The species has two generations per year, the first one appearing from mid-May to mid-June or somewhat later and the second in August or later (Metcalf, 1911).

Distribution of *P. testaceus* in the region of Prilep was determined by the method of mowing with catcher (2003 - 2005). The species was recorded near tobacco and vegetable plots.

According to a great number of authors, the imagos are usually found in meadows, parks, along rivers, roads, etc.

Láska (1978) noted that *P. bicolor* (var. *testaceus*) can be recorded in fields and steppes.

Adults feed on flowers of the weed families Apiaceae, Euphorbiaceae, Brassicaceae etc.

Pek (1971) reported that favorite plants of *P. testaceus* are various species of Umbelliferae family in the forests. Imagos prefer the flowers with simple anatomy, where pollen and nectar are easily accessible. They are particularly attracted by white and yellow flowers (Adashkevich, 1975).

Photo. 2 Male of *P. testaceus*

Photo. 3 Female of *P. testaceus*

P. testaceus is an obligate aphidophagous species, i.e. it develops normally only when fed on leaf aphids.

A number of authors reported it as polyphagous species aphids of various plant species.

P. testaceus larvae were recorded feeding on aphids in vegetable crops, on *Myzus sp*. in *Rumex crispus* L., on various aphids of *Rumex obtusifolius* L., *Arctiumminus Schk*., *Carduus* sp. (Metcalf, 1991).

3. *Pandasyophthalamus (Paragus) tibialis* Fallén, 1817

P. tibialis is one of the smallest hoverflies and a very active predator of aphids.

The species is abundant in Palearctic and Nearctic North American region (Pek, 1981).

According to Simic (1987) it is distributed in the Holarctic region, while Vujic and Glumac (1994) reported Holarctic-Oriental region as its area of distibution.

On the Balkan Peninsula, *P. tibialis* was recorded in all parts of former Yugoslavia, in Bulgaria and Hungary (Simic 1987, Vujic, Glumac 1994, Glumac 1955).

In Macedonia, the occurence of this species was reported in Otesevo Krpac (2006).

The flying period of imagos is from April (March) to September (Simic, 1987; Glumac, 1955; Daminova, 1975).

Photo. 4 Male of *P. tibialis*

Photo. 5 Females of P. *tibialis*

According to Peck (1981), the imagos appear in June and reach the maximum in July-August, visiting several flowers species. The massive flight of the late-summer species *P. tibialis* is in the second decade of August (Mutin, 1983, b), in May-June (Daminova, 1975) and during the summer (Bugg, www.sarep.ucdavis.edu).

Distribution of *P. tibialis* in the region of Prilep was determined by the method of mowing with catcher (2003 - 2005). The species was spread through the whole region, on various biotopes, weeds, meadows, cereal fields, vegetable crops etc.

Many authors reported that *P. tibialis* is most frequently found in meadows, deciduous forests, cereal fields, soybean fields, vegetable cropsand other cultivated and weed species.

The adults feed on pollen and nectar from flowers of weed families Apiaceae, Euphorbiaceae, Brassicaceae etc. Favorite plants to imagos are various plants of Umbelliferae family in the forests. The imagos feed on pollen and nectar from plants like *Scenecio sp., Euphorbia cyparissias, Ranunculus sp., Mentha aquatilis, Sambicus ebulus, Euphorbia sp., Lepidium latifolium, Prunus fruticosa, Eriogonum sp., Polygonum aviculare,* plum, hibiscus etc. (Peck, 1981; B u g g -sarep.ucdavis.edu, etc).

In gardens, the imagos live on flowers of apples, cherries, peaches, pears etc., but in hilly regions they are mainly concentrated on flowers in meadows and bushes.

P. tibialis is an obligate aphidophagous species, which develops normally only when fed on leaf aphids.

According to Daminova (1975), this species feeds on wide spectrum of leaf aphids on many different plants. During its growth period, the larvae can consume up to 1000 aphids.

Photo 6. Paragus sp.

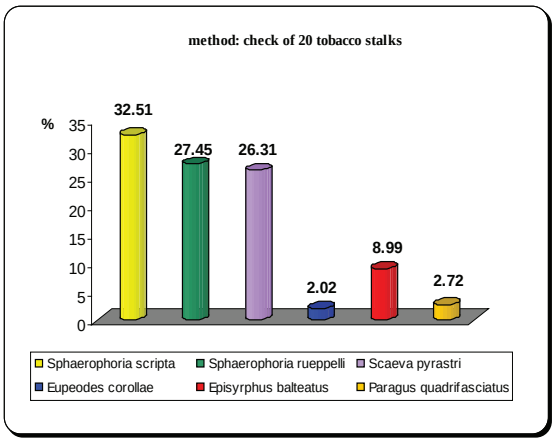
In the region of Strumica *Paragus sp*. have been recorded and we hope it will be a subject of our further investigation (Photo 6).

4. Quantitative analysis of species of the genus Paragus

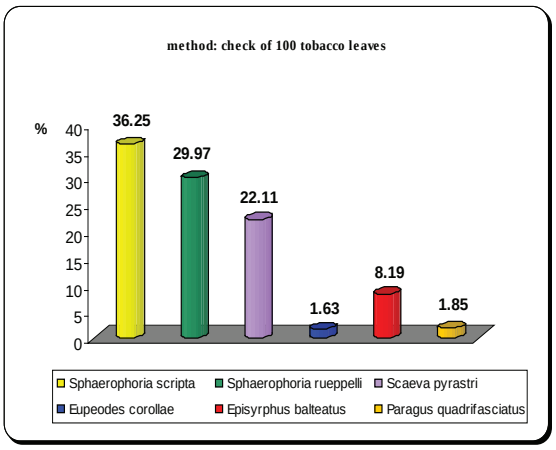
The analysis of quantitative composition of the fauna of Syrphidae family on tobacco in the region of Prilep (2003 - 2005) revealed various levels of hoverflies population, depending on the year.

- By the method of survey of 20 tobacco stalks, 147 individuals of *P. quadrifasciatus* species of the genus Paragus were determined.

In 2003, this species was recorded in August and early September in lower abundance - 6 eggs, 44 larvae, 11 pupae and 1 imago. No parasitised pupae were observed. The maximum number of larvae was recorded on 20 August. In 2004 the abundance of *P. quadrifasciatus* was even lower and no parasitised pupae and imagos were determined. In 2005 the species was recorded only in small number in August - 6 eggs, 46 larvae and 15 pupae. No parasitised pupae or imagos were determined. The share of hoverflies in the total percentage of hoverflies is 2.72% (Graph. 1).



Graph. 1 Total percentage of hoverflies

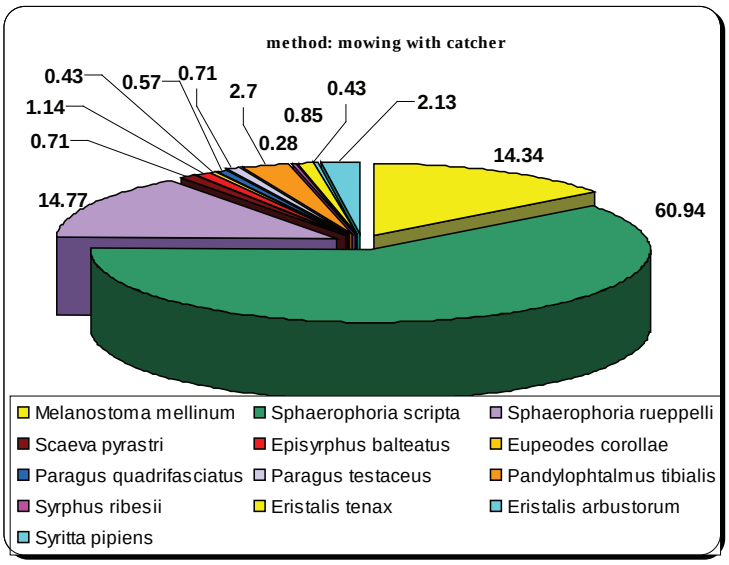


Graph. 2 Total percentage of hoverflies

• By the method of Davies (survey of 100 tobacco stalks), only *P. quadrifasciatus* species of the genus Paragus was determined, with low abundance of larvae and pupae. Imagos were not recorded because only some of tobacco leaves were detached. *P. quadrifasciatus* was represented with 1.85% (Graph. 2).

• No species of this genus were determined by the method of yellow water vessels.

• By the method of mowing with catcher, the following Paragus species were determined in the region of Prilep: *P. tibialis*, with 19 imagos, *P. testaceus* with 5 imagos and *P. quadrifasciatus* with 4 adults. In the three-years investigation, *P. tibialis* was represented with 2.70%, while *P. testaceus* and *P. quadrifasciatus* bellow 1% (Graph. 3).



Graph. 3 Total percentage of hoverflies

5. Faunistic analysis of species of the genus Paragus

P. quadrifasciatus is an obligate aphidophagous species. It is present in tobacco biocenosis from 1 July to 1 September.

Table 1. Total representation of hoverflies according to the applied methods and level of dominance

Methods	*P. quadrifasciatus*			*P. testaceus*			*P. tibialis*		
	total individuals		active dominance	total individuals		active dominance	total individuals		active dominance
	number	%	%	number	%	%	number	%	%
check of 20 stalks	147	79,89							
check of 100 leaves	33	17,94							
sweep net catcher	4	2,17		5	100,00		19	100,00	
Total	184	100,00	2,29	5	100,00	0,06	19	100,00	0,24

Quantitaive analysis was based on 184 individuals of *P. quadrifasciatus*, which accounts for 2.29% of the total number of Diptera Syrphidae individuals on tobacco. *P. quadrifasciatus* appeared as subdominant species in 2003 and 2005, a recedent species in the fauna of Diptera Syrphidae in 2004 and accidental species in tobacco entomocenosis in the region of Prilep (Table 1, 2; Fig.1).

Table 2. Quantitative data of hoverflies population

Year	*P. quadrifasciatus*			*P. testaceus*			*P. tibialis*		
	active dominance	active abundance	constancy	active dominance	active abundance	constancy	active dominance	active abundance	constancy
	%	%	%	%	%	%	%	%	%
2003	4,11	1,46	16,07	0,10	0,04	3,57	0,25	0,09	5,36
2004	0,71	0,43	12,50	0,09	0,45	3,57	0,18	0,11	8,93
2005	2,94	1,39	16,07	-	-	-	0,30	0,14	8,93

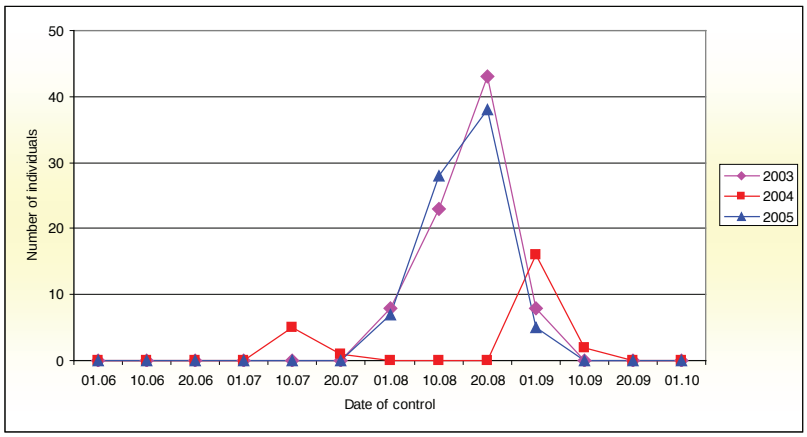


Fig. 1. Dynamics of population of *Paragus quadrifasciatus*, 2003-2005

P. testaceus is an obligate aphidophagous species. In tobacco biocenosis it can be observed in small number and inconstant presence by the middle of July. In that period small colonies of aphids can be found in tobacco fields. In 2005 the species was not recorded (Table 1, 2; Fig.2).

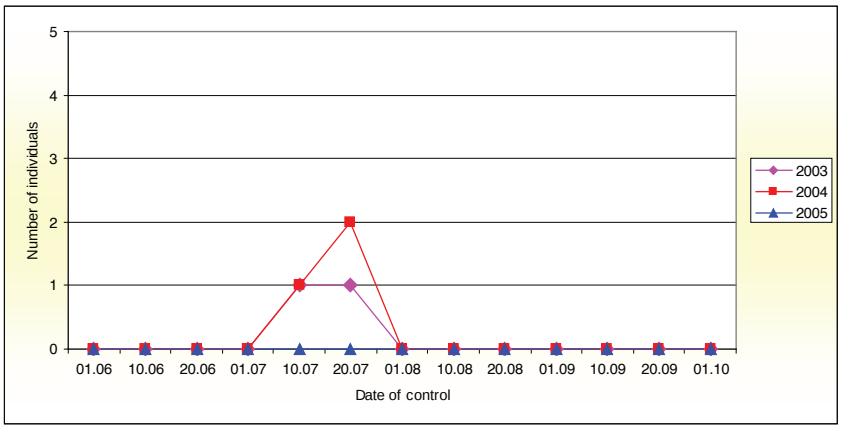


Fig. 2. Dynamics of population of *Paragus testaceus*, 2003-2005

Quantitative analysis is based on 5 individuals of *P. testaceus*, which account for 0.06% Of the total number of Diptera Syrphidae individuals on tobacco. *P. testaceus* has a low level of dominance and belongs to the species accidentally present in tobacco entomocenosis in the region of Prilep

P. tibialis is an obligate aphidophagous species. In tobacco biocenosis it could be observed in small number and inconstantly from 10 June to the end of September in 2003 and 2004. In 2003 it only appeared in a short time period, from 20.08 to 10.09. Quantitative analysis is based on 19 individuals of *P. tibialis*, which account for 0.24% of the total number of Diptera Syrphidae individuals on tobacco. *P. tibialis* appeared as subrecedent species in the fauna of Diptera Syrphidae and accidental species in tobacco entomocenosis in the region of Prilep (Table 1, 2; Fig.3)

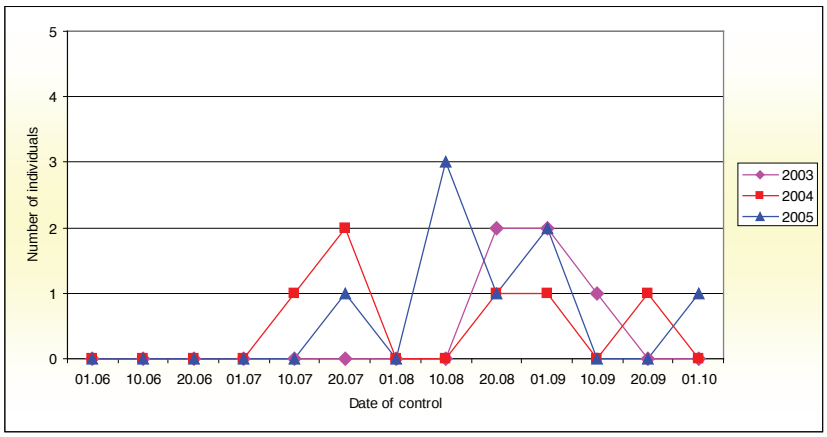


Fig. 3. Dynamics of population of *Pandylophtalmus tibialis*, 2003-2005

CONCLUSION

Species of the genus Paragus are the smallest of all hoverflies**.**

P. quadrifasciatus, P. tibialis and *P. testaceus* are obligate aphidophagous species, i.e. they normally develop only when larvae are fed on leaf aphids.

Since they xerophilic and termophilic species, the climatic factors have an important impact on their development.

P. quadrifasciatus is present in tobacco biocenosis from 1 July to 1 September, in tobacco fields hedges, near meadows, in vegetable gardens and in cereal crops.

P. testaceus was recorded on tobacco in the middle of July, along tobacco plots and vegetable crops.

P. tibialis can be observed in tobacco biocenosis from 10 June to the end of September. This species is spread throughout the whole region of Prilep, in biotops where various crops are grown, in weeds, meadows, cereal fields, vegetable crops, etc.

REFERENCES

1. Adashkevich B. P., 1975. Entomophagous insects on vegetable crops Kolos, Moscow. Commonwealth Bureau of Plant Breeding, 190, pp. 88-121.
2. Bugg, R. L. Habitat manipulation to enhance the effectiveness of aphidophagous hover flies (Diptera: Syrphidae). Article written for Sustainable Agriculture Technical Reviews. www.sarep.ucdavis.edu.
3. Daminova D., 1975. On the biology of the predatory fly - *Paragus tibialis* Flln. pp 88-92 in KhSh Khairutdinov & AG Davletshina (eds) [Ecology and biology of the animals of Uzbekhistan. Part 1. Invertebrates] Fan, Tashkent.
4. Dusek J., Laska P., 1967. Versuch zum Aufbau eines natürlichen Systems mitteleuropäischer Arten der Unterfamilie Syrphinae (Diptera) [A study aimed at contructing a natural classification of central European species of the subfamily Syrphinae (Diptera)]. Acta scientiarum naturalium Academiae scientiarum bohemoslovacae - Brno 1: 349-390.
5. Gao J., 1991. Observations on *Paragus quadrifasciatus* (Syrphidae) in Tonghua country. Chinese Journal of Biological Control v.7(2) p.95. General Station of Agriculture, Tonghua County, Jilin, www. ksu.edu/issa/aphids/reporthtml/trans 49.
6. Glumac S., 1995. Osolike muve Srbije (Syrphidae, Diptera) iz zbirke Prirodnjačkog muzeja Srpske zemlje u Beogradu. Zaštita bilja, br. 27, str. 1-43, Beograd.

7. Janusevska V., 2001. Predatori i paraziti na lisnata voska *Myzus persicae* Sulz. na tutunot. Magisterski trud. Zemjodelski fakultet tutunot. Magisterski trud. Zemjodelski fakultet Skopje.
8. Krpač V., 2006. Fauna osolikih muva (Diptera: Syrphidae) Makedonije. Doktorska disertacija, Prirodno-matematički fakultet, Novi Sad.
9. Krsteska V., 2007. Afidofagni osoliki muvi (Diptera, Syrphidae) na tutunot vo Prilepsko. Doktorska disertacija. Fakultet za zemjodelski nauki i hrana- Skopje.
10. Laska P., 1978. Current knowledge of the feeding specialisation of different species of aphidophagous larvae of Syrphidae. (in French) Ann zool ecol anim 10(3): 395-7.
11. Metcalf C. L., 1911. *Paragus bicolor* (Fabricius). Life-Histories of Syrphidae II, Nov., 1911]. The Ohio Naturalist, Vol. XI, No. 7, pp. 337-344, 2 plates, May, 1911, https://kb.osu.edu/dspace/bitstream/ 1811/ 1733/ 1/ V12N01 _397.pdf.
12. Mutin V. A., 1983. Species diversity and ecology of hoverflies (Diptera, Syrphidae) visiting some flowers of the region. pp 100-109 in RG Soboleva (ed) Obzor otdel'nykh otryadov nasekomykh Dal'nego Vostoka [Systematics and ecological-faunistic review of insect Orders in the Far East], Academy of Sciences of USSR, Vladivostok, USSR.
13. Pek L.V., 1971. Syrphidae (Diptera) - predators of aphids on fruit trees in Kirgizia. pp 69-74 in LV Pek (ed) Reports on arthropod entomophages of Kirgizia". Frunze.
14. Pek L.V., 1981. The syrphid fauna of mountain pastures of the steppe belt of the northern slopes of the Kirgizian Ala-Tau. Ent Issled Kirgizii 14: 44-52.
15. Simic S., 1987. Fauna Durmitora Sveska 2: Syrphidae (Insecta, Diptera) biogeografska i ekoloska analiza faune osolikih muva Durmitora sa osvrtom na faunu osolikih muva Crne Gore. Crnogorska akademija nauka i umjetnosti, Posebna izdanja, knjiga 21, Odjeljenje prirodnih nauka, kniga 13, Titograd, str 11-142.
16. Vujic A., 1987. Sirfide (Diptera:Syrphidae) Vrsackih planina. Magistarski rad, Univerzitet u Novom Sadu, PMF, 1-211.
17. Vujic A. Glumac S. 1994. Fauna osolikih muva (Fruske gore. Matica Srpska, Novi Sad.
18. Wu Z., Schenk-Hamlin D., Zhan W., Ragsdale D., Heimpel G., (2004). The soybean aphid in China. A historical review ann. entomol. soc. am. 97(2): 209 218.