



ЕНТОМОФАГИТЕ ОТ НАДСЕМЕЙСТВОТА *PROCTOTRUPOIDEA*,  
*PLATYGASTROIDEA* И *CERAPHRONOIDEA* (HYMENOPTERA) В  
ОВОЩНИТЕ ГРАДИНИ НА АГРАРЕН УНИВЕРСИТЕТ - ПЛОВДИВ

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ENTOMOPHAGY OF THE SUPERFAMILIES *PROCTOTRUPOIDEA*,  
*PLATYGASTROIDEA* AND *CERAPHRONOIDEA* (HYMENOPTERA) IN  
APPLE ORCHARDS IN THE AGRICULTURAL UNIVERSITY OF PLOVDIV

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**Abstract:** 188 specimens of the superfamily *Proctotruoidea*, 1346 specimens of the superfamily *Platyastroidea*, and 322 specimens of the superfamily *Ceraphronoidea* were found during a research in the apple orchards.

**Key words:** biodiversity, *Proctotruoidea*, *Ceraphronoidea*, *Hymenoptera*, biological control, apple orchard.

**Introduction.** The parasitic insects of the Order Hymenoptera dominate in the majority of entomophagies on the habitual orchard pests. The parasitoids of the superfamilies *Proctotruoidea*, *Platyastroidea* and *Ceraphronoidea* distinguish with their important role among them.

Apple orchards are distinctive for the Plovdiv region which is the major orchard area in Bulgaria.

This article presents preliminary information on the results of the research on the entomophagies from the Proctotrupoidea complex in the apple plantations in the experimental field of the Agricultural University – Plovdiv.

**Materials and Methods.** The research was conducted in 2007 in the apple plantation at the Entomology Department situated in the experimental field of the Agricultural University - Plovdiv.

Traps of the type "Malaise trap" were used for the purposes of the generic structure research and for tracing the seasonal flight dynamics of entomophagies. The material caught was collected every 15 days. Under laboratory conditions, under magnifying glass, the Hymenoptera were then divided into groups in descending order, namely: families, subfamilies, genres and species groups.

Masner and Huggert 1989 offer new classification of the Family *Platygastridae*, as they divide it into the subfamilies, namely: *Scelotrachelinae* and *Platygastrinae*. In their opinion the former subfamily *Inostemmabinae* is extremely heterogenic and is not a monophyletic unit. Based on this statement, they distribute its genres and species among two subfamilies. They do not group in their classification the species into tribes, but form separate clusters.

In the present article we abide by Kozlov's classification system (1970), which is very convenient to work with and due to methodical reasons (for comparativeness of the current results with similar ones from preceding researches).

**Results and Discussion.** The orchard gardens are especially rich in pests and beneficial akari and insects. They are a biotope, the biocenosis of which is very dynamic and unstable due to the multiple treatments with pesticides.

Some of the more important pests in the apple orchards are as follows: akari, aphides, leaf-nibbling caterpillars, leaf-rollers, Cankerworms, fruit wasps, coccids, etc. During the period of vegetation the main spaying is against the Codling moth.

According to literature data for Ukraine (Zerova M. D. et al., 1992), the species of *Ichneumonoidea*, *Chalcidoidea* (*Hymenoptera*) and *Tachinidae* (*Diptera*) dominate in the complex of entomophagies on pests on apple fruits and leaves. In this complex, the superfamily *Platygastridae* is present by 19 species of 2 genres of the subfamily *Telenominae* (*Scelionidae*). All telenomini are oophages. Most of them, mostly species of the Genus *Trissolcus*, are parasitoids on the shield bugs. The latter refer to the secondary pests on vegetative and generative apple organs (they damage buds, leaves).

The parasitoids on the harmful *Lepidoptera* are another group, represented by species of the Genus *Telenomus*. The following specialized entomophagies also belong to this group: *Telenomus phalaenarum* Ne., parasitoid on the gipsy moth and the brown-tail moth (Germanov, 1975); *Telenomus laevisculus* Ratz., parasitoid on the lackey moth (Germanov, 1977); *Gryon muscaeformis* (Ne.) (Petrov, 1995).

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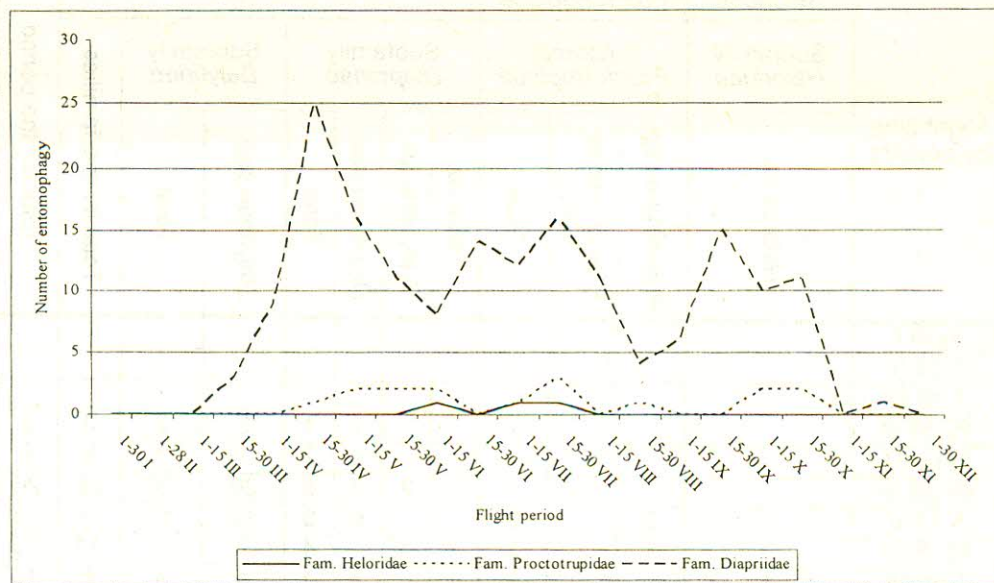
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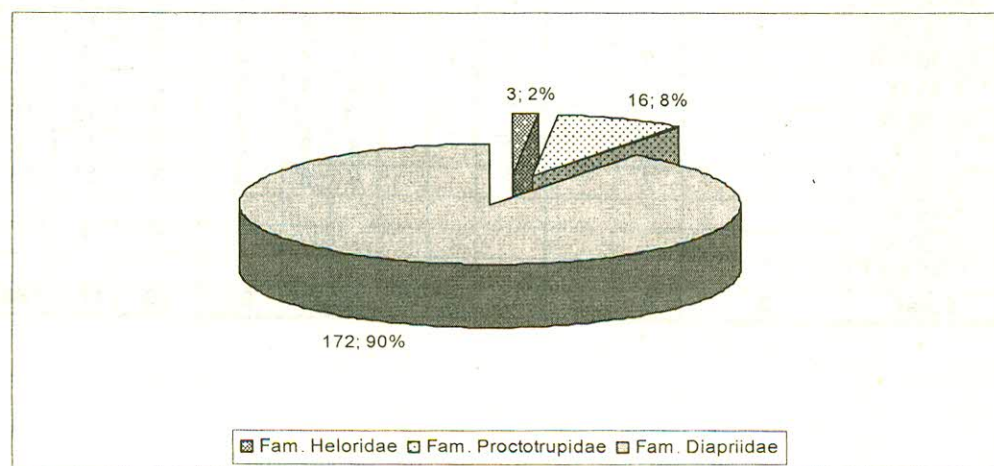
**Table 1.** Flight time of entomophagies of the families *Heloridae*, *Proctotrupidae* and *Diapriidae* divided by families and species groups in 2007.

Flight time by periods	Family <i>Heloridae</i>	Family <i>Proctotrupidae</i>			Family <i>Diapriidae</i>						Total for the period	
	Subfamily <i>Helorinae</i>	Subfamily <i>Proctotrupidinae</i>			Subfamily <i>Diapriinae</i>			Subfamily <i>Belytinae</i>		Total for the families		
	<i>Helorus sp.</i>	<i>Proctotrupes sp.</i>	<i>Proctotrupidinae spp.</i>	Total	<i>Psilus sp.</i>	<i>Trichopria sp.</i>	<i>Diapriinae spp.</i>	Total	<i>Belytinae spp.</i>			Total
1-30 I												
1-28 II												
1-15 III												
15-30 III							1	1	2	2	3	3
1-15 IV							2	2	7	7	9	9
15-30 IV			1	1		2	3	5	20	20	25	26
1-15 V		2		2			6	6	10	10	16	18
15-30 V		1	1	2	1	3		4	7	7	11	13
1-15 VI	1		1	1	1		3	4	4	4	8	10
15-30 VI						2	9	11	3	3	14	14
1-15 VII	1					10	6	7	5	5	12	13
15-30 VII	1		2	2			6	6	1	10	16	19
1-15 VIII						1	8	9	2	2	11	11
15-30 VIII		1		1	1		1	2	2	2	4	5
1-15 IX							4	4	2	2	6	6
15-30 IX					1		11	12	3	3	15	15
1-15 X		2		2			8	8	2	2	10	12
15-30 X		2		2			8	8	3	3	11	13
1-15 XI												
15-30 XI									1	1	1	1
1-30 XII												
<b>Total:</b>	<b>3</b>	<b>8</b>	<b>5</b>	<b>13</b>	<b>4</b>	<b>9</b>	<b>76</b>	<b>89</b>	<b>83</b>	<b>83</b>	<b>172</b>	<b>188</b>

**Figure 1.** Seasonal dynamics of the entomophagies of the families *Heloridae*, *Proctotrupidae* and *Diapriidae*.



**Figure 2.** Numbers of the families of *Proctotrupoidea*





The deficiency of more data in the literature on the truly important role of the *Proctotrupeoidea*, *Platygastroidea* and *Ceraphronoidea* entomophagies in the bio-control of the pests in an orchard is a good example for the level of examination of these three superfamilies in these important agrocenoses.

**Table 1** presents data on the number of entomophagies of the families *Heloridae*, *Proctotrupidae* and *Diapriidae* divided into genera and species groups, and flight periods (15 days) for 2007. According to the opinion up to now, these three families form one superfamily called *Proctotrupeoidea*.

**Figure 1** shows the dynamics in the number of entomophagies from the three families.

The curve in the number of the entomophagies of the family *Heloridae* is slightly seen, for the family has been represented by only three specimens collected in June and July. Their number is probably connected with the number dynamics of their hosts – the lacewings *Chrysopidae* (*Neuroptera*).

The curve in the numbers of entomophagy of the family *Proctotrupidae* is more visible - the family is presented by 13 specimens, which can be met from mid-April (1 specimen) to mid-October (2 specimens). 8 species of them are of the Genus *Proctotrupes*, and the others are mixed with non-established genus and species belonging for the moment (*Proctotrupinae spp.*). The representatives of the family are of lower numbers, but may be seen during the entire vegetative period. Their hosts are larvae of *Coleoptera* and *Diptera*.

The most visible is the curve of the number of entomophagy of the family *Diapriidae*, which is presented by 172 specimens. They appear in mid-March (3 specimens) and can be observed up to mid-November (1 specimen). There are 5 peaks in the numbers: the second halves of April (25), June (14 specimens), July (16 specimens), September (15 specimen) and October (11 specimens).

The family is divided into 2 subfamilies. The first one – subfamily *Diapriinae* (89 specimens) is presented by genera: *Psilus* (4 specimens), *Trichopria* (9 specimens) and mixed genus group (*Diapriinae spp.* – 76 specimens). Hosts of the subfamily are mostly the *Diptera*, some *Coleoptera* and others.

The second subfamily – *Belitinae* (83 specimens), is represented by entomophagies of non-established genus belonging. Hosts of the family members are *Diptera*.

**Figure 2** shows the numbers of the families of *Proctotrupeoidea*: *Heloridae* – 3 specimens (2 %), *Proctotrupidae* – 13 specimens (7 %), *Diapriidae* – 172 specimens (91 %).

**Figure 3** shows the number dynamics of the entomophagies from the three subfamilies.

**Table 2** presents the seasonal dynamics of parasitoids of the family *Scelionidae* (superfamily *Platygastroidea*). The 1166 specimens collected are from 3 subfamilies, namely: *Scelioninae*, *Teleasinae* and *Telenominae*.

The subfamily Telenominae (628 specimens) is the biggest one, as its representatives may be observed during almost the entire year - from February to the end of December. The numbers are extremely high during the active vegetative period: May - 63 specimens (27 + 36 specimens), June - 100 specimens (29 + 71 specimens), July - 170 specimens (47 + 123 specimens), August - 125 specimens (64 + 61 specimens) and September - 97 specimens (28 + 69 specimens). 5 easily-recognized peaks in the numbers can be observed: the second half of April (36 specimens), June (71 specimens), July (123 specimens), September (69 specimens) and October (19 specimens).

The registered hymenopterous are from 2 genera: *Trissolcus* (50 specimens) - parasitoids in the eggs of bugs (*Pentatomoidea*) and *Telenomus* (578 specimens) parasitizing into the eggs of *Lepidoptera*, *Hemiptera*, *Chrysopidae*, *Neuroptera*, *Diptera* (*Tabanidae*), *Homoptera* (*Cicadidae*), and some *Hymenoptera*.

Second in number is the family *Scelioninae* (394 specimens). Its representatives can be observed during all seasons. Yet, in January and November specimens were not registered. They are the most numerous in: July - 77 specimens (31 + 46 specimens), August - 127 specimens (57 + 70 specimens) and September - 147 specimens (51 + 96 specimens) with 2 distinct seasonal peaks - in the second half of August (70 specimens) and in September (96 specimens).

Subfamily *Scelioninae* includes 10 registered genera, namely: *Macroteleia* - 10 specimens, *Probaryconus* - 218 specimens, *Anteromorpha* - 3 specimens, *Apegus* - 3 specimens, *Scelio* - 5 specimens, *Ceratobaeus* - 1 specimen, *Gryon* - 72 specimens, *Eremioscelio* - 2 specimens, *Idris* - 74 specimens, and *Aradophagus* - 6 specimens.

There is no reliable information regarding the hosts of the most numerous genus - *Probaryconus*, but the group that it belongs to (*Calliscelionini*) parasitizes in the eggs of *Gryllidae*. The entomophagies of the second largest genus - *Idris*, are parasitoids on the spiders of the families *Lycosidae* and *Saldidae*. The third largest genus - *Gryon*, parasitizes in bugs (*Heteroptera*) of different families. All these families consist of serious pests in agriculture.

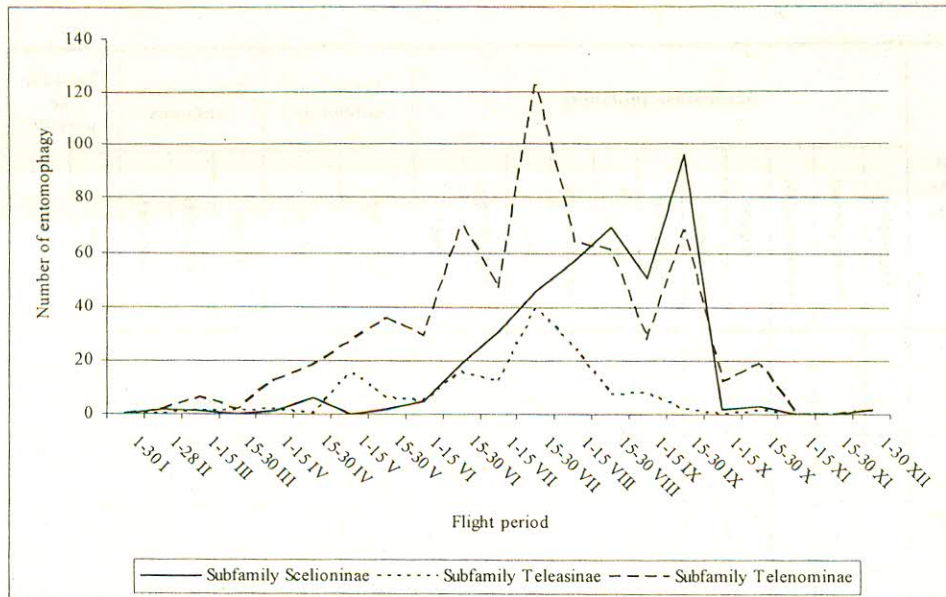
The third largest subfamily is the subfamily *Teleasinae* (144 specimens). Its representatives have been registered in all seasons, except in January, February and November. Higher numbers have been observed in May - 22 specimens (16 + 6 specimens), June - 21 specimens (5 + 16 specimens), July - 52 specimens (12 + 40 specimens), and August - 32 specimens (25 + 7 specimens). Three peaks can be observed in the seasonal activity, namely: the first half of May (16 specimens), the second half of June (16 specimens), and July (40 specimens). The subfamily is presented by 2 registered genera: *Teleas* and *Trimorus*. The entomophagies of these two genera parasites in eggs of *Carabidae* (*Coleoptera*).



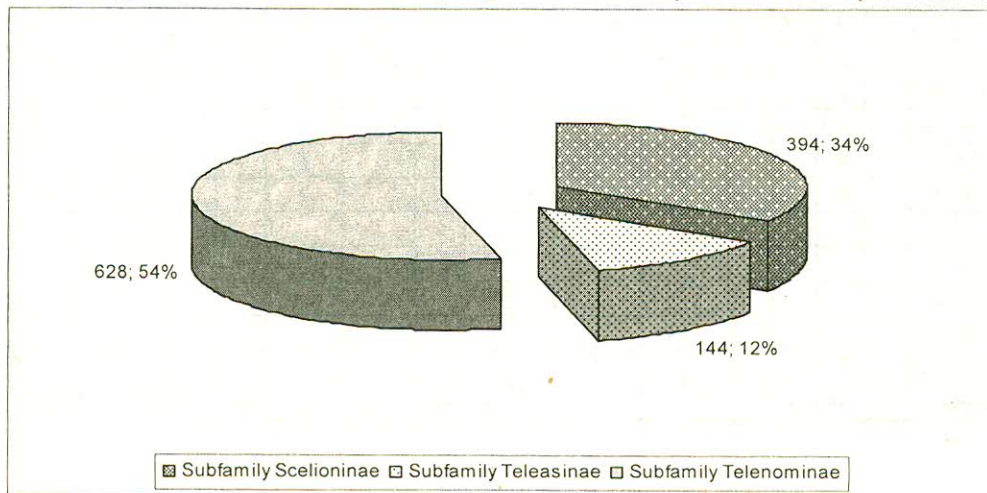
**Table 2.** Genus structure and flight periods of the entomophagy of the family *Scelionidae* in 2007

Flight time by periods	Scelioninae subfamily										Teleasinae subfamily		Telenominae subfamily			Total for the periods		
	<i>Macrotelea</i>	<i>Probaryconus</i>	<i>Anteromorpha</i>	<i>Apegus</i>	<i>Scelio</i>	<i>Calotelea</i>	<i>Gryon</i>	<i>Eremioscelio</i>	<i>Idris</i>	<i>Aradophagus</i>	<i>Total</i>	<i>Trimorus</i>	<i>Teleas</i>	<i>Totalt</i>	<i>Trissolcus</i>	<i>Telenomus</i>	<i>Total</i>	
1-30 I																		
1-27 II		1					1				2			1	1	2	4	
1-15 III							1			1	1		1		6	6	8	
15-30 III											1		1	1	1	2	3	
1-15 IV							1			1	2		2	4	9	13	16	
15-30 IV							6			6					18	18	24	
1-15 V											16		16		27	27	43	
15-30 V								1	1	2	6		6	4	32	36	44	
1-15 VI							3	2		5	4	1	5	2	27	29	39	
15-30 VI				1			5	10	3	19	16		16	10	61	71	106	
1-15 VII	2	3	1	1	1	1	8	1	11	2	31	12		12	3	44	47	90
15-30 VII	5	21		1	1		10		8		46	40		40	12	111	123	209
1-15 VIII	3	25			2		8		19		57	24	1	25	2	62	64	146
15-30 VIII		39	1		1		17	1	11		70	6	1	7	8	53	61	138
1-15 IX		46					5				51	3	5	8		28	28	87
15-30 IX		80	1				7		8		96		2	2	3	66	69	167
1-15 X		1							1		2					12	12	14
15-30 X		2							1		3	1		1		19	19	23
1-15 XI																		
15-30 XI																		
1-30 XII								2		2	2		2		1	1	5	
Общо:	10	218	3	3	5	1	72	2	74	6	394	134	10	144	50	578	628	1166

**Figure 3.** Seasonal dynamics of the entomophagy of the three subfamilies of the family *Scelionidae*



**Figure 4.** Number of entomophagies of the family *Scelionidae* by subfamilies





**Figure 4.** shows the number of entomophagies of the family *Scelionidae* divided into subfamilies, namely: *Telenominae* – 628 specimens (54 %), *Scelioninae* – 394 specimens (34 %), and *Teleasinae* – 144 specimens (12 %).

**Table 3.** presents data on the seasonal dynamics of the entomophagies of the family *Platygastridae* ( superfamily *Platygastroidea*)

**Figure 5** shows the seasonal dynamics of the two subfamilies of *Platygastridae*.

Subfamily *Inostemmatinae* has been observed in the period May-August. Subfamily *Platygastrinae* has been observed during all the seasons. It has not been observed only in February. The largest numbers have been observed in April – 32 specimens (13 + 19 specimens), May – 49 specimens (33 + 16 specimens), June – 27 specimens (20 + 7 specimens) and September – 18 specimens (10 + 8 specimens). Constantly diminishing peaks in the numbers are observed in the first halves of May – 33 specimens, June – 20 specimens, September – 10 specimens and October – 7 specimens

Subfamily *Inostemmatinae* is presented by the genus *Inostemma* (4 specimens) and the genus group *Inostemmatini spp* (4 specimens). The representatives of the subfamily have been registered in May, June, July and August. Hosts are insects of the genera *Homoptera*, *Coleoptera* and *Diptera*.

The second subfamily - *Platygastrinae*, is presented by the genera *Isocybus* (10 specimens), and *Leptacis* (28 specimens), and the genus groups: *Platygaster sp 1*, *sp 2*, *sp 3*, *sp 4*, *Synopeas sp 1*, and *Synopeas (Sactogaster) sp 2*. Most numerous are *Platygaster sp 2* (90 specimens) and *Leptacis* (28 specimens). Hosts of the entomophagies of the subfamily are the flies of the family *Cecidomyiidae*.

**Figure 6** shows the number of the subfamilies of the family *Platygastridae*. Subfamily *Inostemmatinae* is presented by 8 specimens (4 %), and subfamily *Platygastrinae* - by 172 specimens (96 %).

**Table 4** presents the number and the seasonal dynamics of the two families of the superfamily *Ceraphronoidea* .

**Figure 7** shows the seasonal dynamics of the two families and the whole superfamily.

The first family – *Ceraphronidae*, has been observed from April to the end of October. The numbers have been rising slightly during the months: April – 13 specimens (4+9 specimens), May – 19 specimens (13+6 specimens), June – 31 specimens (11+20 specimens), July – 68 specimens (21+47 specimens), as there has been a peak marked in August – 80 specimens (60+20 specimens), followed by a decrease marked in September – 18 specimens (8+10 specimens) and October – 13 specimens (8+5 specimens). Peaks in the numbers can be observed in the first halves of May (13 specimens), and August (60 specimens). Hosts are *Homoptera* and some *Hymenoptera*.

The second family – *Megaspilidae*, has been observed from the second half of March to the mid-October. The biggest number has been registered in May – 29 specimens (15 + 14 specimens), June – 20 specimens (13 + 7 specimens), and July –

15 specimens (3 + 12 specimens). Peaks in the numbers have been marked in the first half of May (15 specimens), and in the second half of July (12 specimens). The curve for the whole superfamily shows 4 distinctive peaks, namely: the beginning of May (28 specimens), the second halves of June (27 specimens) and July (59 specimens), and the beginning of August (63 specimens). Hosts are *Homoptera*, some *Hymenoptera* and others.

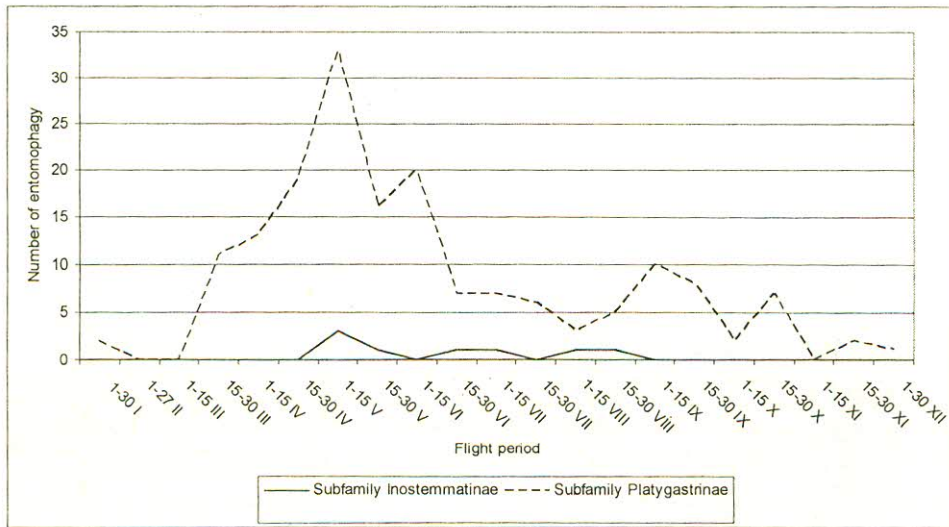
**Figure 8** shows the number of the two families: *Ceraphronidae* – 242 specimens (75 %), *Megaspilidae* – 80 specimens (25 %).

**Table 3.** Genus structure and flight periods of the entomophagies of the family *Platygastridae* (superfamily *Platygastroidea*) in 2007.

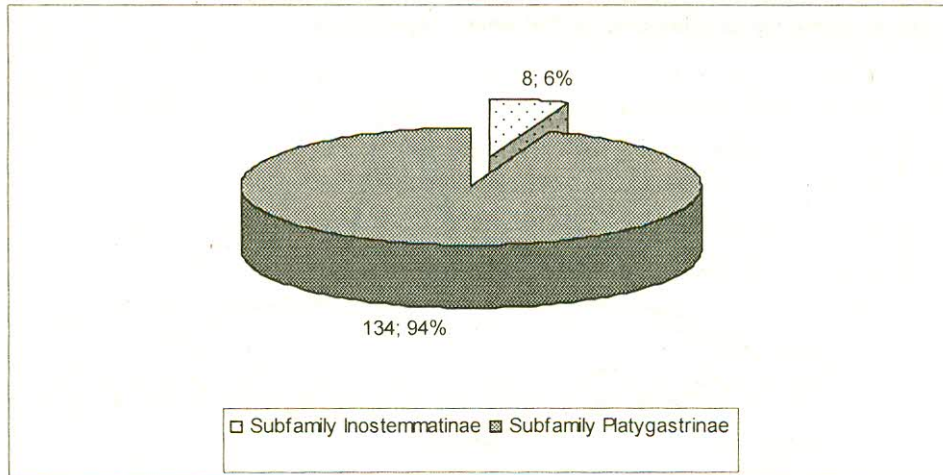
Flight period	Subfamily Inostemmatinae			Subfamily Platygastrinae								Total for the period	
	<i>Inostemma</i>	<i>Acerotella</i>	Total	<i>Isocybus</i>	<i>Platygas.sp1</i>	<i>Platygas.sp2</i>	<i>Platygas.sp3</i>	<i>Platygas.sp4</i>	<i>Synopeas 1</i>	<i>S.sactogaster sp2</i>	<i>Leptacis</i>		Total
1-30 I						1				1		2	2
1-27 II													
1-15 III													
15-30 III					1	8			1		1	11	11
1-15 IV						9	3	1				13	13
15-30 IV						14	3	2				19	19
1-15 V	3		3			14	8	7			4	33	36
15-30 V		1	1			8	4	2			2	16	17
1-15 VI				3		10				2	5	20	20
15-30 VI	1		1			3	2				2	7	8
1-15 VII		1	1	1		4				1	1	7	8
15-30 VII						1					5	6	6
1-15 VIII		1	1								3	3	4
15-30 VIII		1	1			3					2	5	6
1-15 IX						7			1		2	10	10
15-30 IX						6	2					8	8
1-15 X						1			1			2	2
15-30 X				4	2	1						7	7
1-15 XI													
15-30 XI				2								2	2
1-30 XII											1	1	1
<b>Total:</b>	<b>4</b>	<b>4</b>	<b>8</b>	<b>10</b>	<b>3</b>	<b>90</b>	<b>22</b>	<b>12</b>	<b>3</b>	<b>4</b>	<b>28</b>	<b>172</b>	<b>180</b>



**Figure 5.** Seasonal dynamics of the entomophagies of the two subfamilies of *Platygastridae*



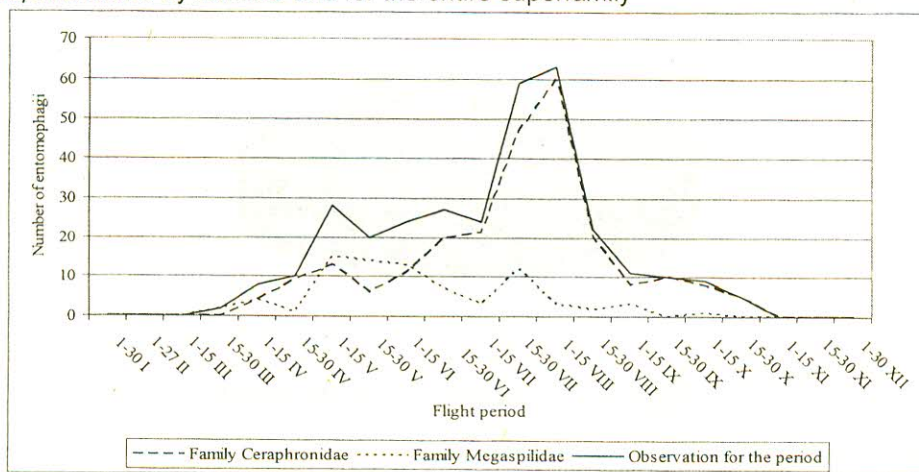
**Figure 6.** Number of the entomophagies of the family *Platygastridae* by subfamilies



**Table 4.** Flight time of the entomophagies of the superfamily *Ceraphronoidea* in 2007.

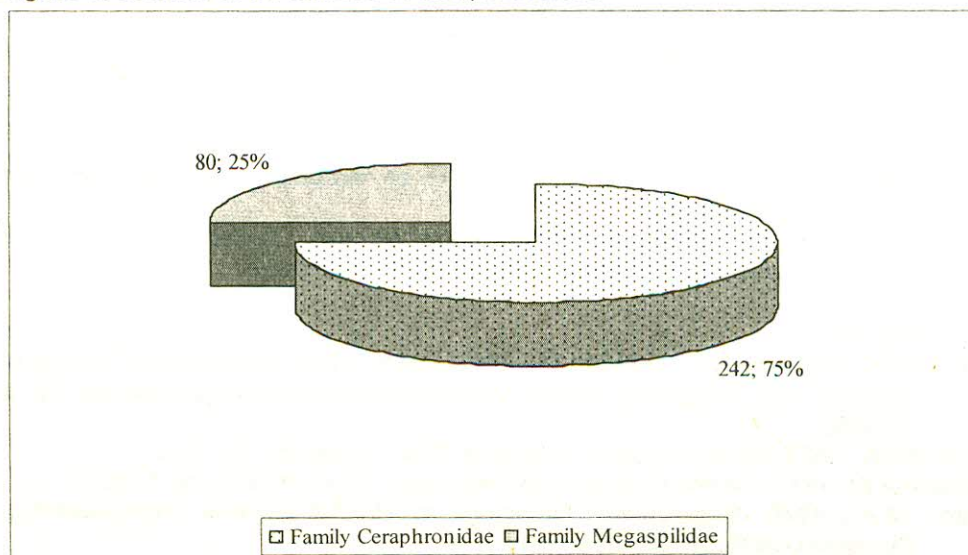
Flight time in periods	Family <i>Ceraphronidae</i>	Family <i>Megaspilidae</i>	Total for the superfamily
1 – 30 I			
1 – 27 II			
1 – 15 III			
15 – 30 III		2	2
1 – 15 IV	4	4	8
15 – 30 IV	9	1	10
1 – 15 V	13	15	28
15 – 30 V	6	14	20
1 – 15 VI	11	13	24
15 – 30 VI	20	7	27
1 – 15 VII	21	3	24
15 – 30 VII	47	12	59
1 – 15 VIII	60	3	63
15 – 30 VIII	20	2	22
1 – 15 IX	8	3	11
15 – 30 IX	10		10
1 – 15 X	8	1	9
15 – 30 X	5		5
1 – 15 XI			
15 – 30 XI			
1 – 30 XII			
<b>Total:</b>	<b>242</b>	<b>80</b>	<b>322</b>

**Figure 8.** Seasonal dynamics of the entomophagies of the superfamily *Ceraphronoidea* by families and for the entire superfamily





**Figure 9.** Number of the families of *Ceraphronoidea*



### Conclusions.

1. There have been 188 specimens registered of the superfamily *Proctotrupoidea*. They belong to, as follows: the family *Heloridae* - 3 specimens (2 %), the family *Proctotrupidae* - 13 specimens (7 %), and the family *Diapriidae* - 172 specimens (91 %).

2. There have been 1346 specimens registered of the superfamily *Platyastroidea*. They are grouped as follows: the family *Scelionidae* - 1166 specimens (87 %), and the family *Platygastridae* - 180 specimens (13 %).

3. There have been 322 specimens registered of the superfamily *Ceraphronoidea*. They belong to the family *Ceraphronidae* - 242 specimens (75 %), and the family *Megaspilidae* - 80 specimens (25 %).

4. *Platyastroidea* dominates over the superfamilies by 1346 specimens (73 %), followed by *Ceraphronoidea* - by 322 specimens (17 %), and *Proctotrupoidea* - by 188 specimens (10 %).

5. The seasonal dynamics of the entomophagies registered probably corresponds to the dynamics of their hosts. The hosts are distinguished with the wide range of their genus composition, which preconditions the efficient activity of the entomophagies of the superfamilies examined, as active regulators of the number of pests in orchards.

6. The presence of some genera and species groups that have not been specified so far gives grounds for supposing the possible registration of new species of the orchard fauna and the Bulgarian fauna.

7. The morphological signs of some of the specimens of the genus *Telenomus* show 4 species that are new to the science. They have been named as follows: *Telenomus (T) stilbo* Petrov et Kononova sp.n, *Telenomus (T) indiligens* Petrov et Kononova sp.n, *Telenomus (T) lampro* Petrov et Kononova sp.n, and *Telenomus (T) faustus* Petrov et Kononova sp.n. These are to be morphologically described and published in a separate article.

8. Additional researches should be done on the species composition of subfamilies *Proctotrupoidea*, *Platygastridae* and *Ceraphronidae*.

### Bibliography

- Austin A.D., Johnson N.F., Downton M., 2005.** Systematics, evolution and biology of scelionid and platygastroid Wasp. Annual Review Entomology Australia, 50, p 553-582.
- Germanov A., 1975.** Brown-tail moth oophages. Plan. protection, No. 7, 3.
- Germanov A., 1977.** Common lackey moth oophages. Environment, No. 1, 69-71.
- Kozlov M.A., 1970.** Supergeneric groupings of *Proctotrupoidea*. (*Hymenoptera*). Rev.ent5.USSR, 39: 203-226.
- Masner L., 1993.** [Superfamily *Ceraphronidae*, p. 566-569] in **Goulet H., Huber J.T.** ed. [*Hymenoptera* of the world: an identification guide to families].
- Masner L., Huggert L., 1989.** World review and keys to genera of the subfamily by *Inostemmatinae* with reassignment of the taxa to the *Platygastrinae* and *Sceliotrachelinae* (*Hymenoptera*, *Platygastridae*). Mem.Entomol.Soc.Can. 147: 1-214.
- Murphy N.P., Carey D., Castro L.R., Austin A.D., 2007.** Phylogeny of the Platygastroid wasps (*Hymenoptera*), based on sequences from the 18 S rRNA, 28 S rRNA and cytochrome oxidase I genes: implication for the evolution of the ovipositor system and host relationships. Biological Journal of the Linnean Society, Australia 91(4), p 653-669.
- Petrov S., 1995.** Eggeaters of the family *Scelionidae* (*Proctotrupoidea*, *Hymenoptera*) and biological fight against orchard pests. Third National Entomophagy Scientific Conference, 18-20 September, 1995, p. 247-249.
- Zerova M.D., Tolkanits V.I., Kotenko A.G., Harolskyi N.B., Fursov V.N., Farinets S.I., Kononova S.V., Nikitenko G.N., Melika Zh.G., Sviridov S.V., 1992.** Entomophagies-pests in orchards in southwest SSSR. Kiev, Naukova dumka, p. 274.