

CERAPHRONIDAE AND MEGASPILIDAE (HYMENOPTERA: CERAPHRONOIDEA) – THE CURRENT STATE OF KNOWLEDGE IN ROMANIA

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The aim of the present study is the better knowledge of Ceraphronidae and Megaspilidae in Romania, based on personally papers previously published and on a new data obtained during the last 10 years. In Romania, before my first published papers (Teodorescu, 1967–1972), Ceraphronoidea superfamily has practically unknown. Our current list includes a number of 64 species (21 of Ceraphronidae and 43 of Megaspilidae), of which 59 species (20 of Ceraphronidae and 39 of Megaspilidae) and five genera (two of Ceraphronidae and three of Megaspilidae) were mentioned for the first time in the Romanian fauna. New hosts have also been identified for some *Dendrocerus* species. A special attention was paid to some species of *Dendrocerus*, as secondary parasitoids (hyperparasitoids), so tertiary consumers, and of other *Dendrocerus* species, as primary parasitoids, so secondary consumers. Some comments are added regarding the role of *Dendrocerus* species (with validity for all parasitoids) in populations control and in natural balance.

Keywords: Ceraphronoidea, Ceraphronidae, Megaspilidae, *Dendrocerus*, Romania.

INTRODUCTION

The Ceraphronoidea are a small hymenopterans superfamily that includes only two extant families, Ceraphronidae and Megaspilidae, and other two extinct families, Radiophronidae (with two genera: *Radiophron* Ortega-Blanco, Rasnitsyn & Delclòs and *Microcostaphron* Ortega-Blanco, Rasnitsyn & Delclòs) and Stigmaphronidae (with five genera: *Allocotidus* Muesebeck; *Aphrostigmon* Rasnitsyn; *Elasmomorpha* Kozlov; *Hippocoon* Kozlov and *Stigmaphron* Kozlov).

The two extant families count a total of 27 genera, over 800 described species and 2.000 estimated worldwide. The species of Ceraphronoidea are unique among the Apocrita by the existence of two spurs on the anterior tibiae, while the rest of the species in this group have a single tibial spur.

The Ceraphronoidea superfamily is widely distributed, in the major biogeographical regions: Afrotropical, Australasian and Oceanian, Nearctic, Neotropical, Oriental and Palaearctic.

The superfamily Ceraphronoidea is one of the least studied groups of parasitoid hymenoptera, and the biology for many species, their hosts are still unknown, especially in the case of Ceraphronidae family.

In nature, the larvae of some species of Ceraphronidae and Megaspilidae are integrated in certain trophic networks, as primary or secondary parasitoids (hyperparasitoids), their hosts being larvae or pupae of other insect species.

Ceraphronidae (= Calliceratidae) family comprises over 379 species and 15 genera: *Abacoceraphron* Dessart; *Aphanogmus* Thomson; *Ceraphron* Jurine; *Cyoceraphron* Dessart; *Donadiola* Dessart; *Ecitonetes* Brues; *Elysoceraphron* Szelenyi; *Gnathoceraphron* Dessart & Bin; *Homaloceraphron* Dessart & Masner; *Kenitoceraphron* Dessart; *Masner* Deans & Mikó; *Microceraphron* Szelenyi; *Pteroceraphron* Dessart; *Retasus* Dessart and *Synarsis* Forster (Dessart, 1965, 1994, 1995a; Masner & Dessart, 1967; Muesebeck, 1979; Masner, 1993; Mikó & Deans, 2009). *Masner* genus and *Masner lubomirus* species were described from Australia and Fiji (Deans & Mikó, 2009).

In Europe, from Ceraphronidae family was identified five genera: *Aphanogmus* (with 47 species), *Ceraphron* (with 50 species), *Elysoceraphron* (with one species, *E. hungaricus* Szelenyi, 1936), *Microceraphron* (with one species, *M. subterraneus* Szelenyi, 1935) and *Synarsis* (with six species).

Megaspilidae family comprises over 497 species, 12 genera and two subfamilies (Megaspilinae and Lagynodinae). Megaspilinae subfamily is represented by seven genera: *Conostigmus* Dahlbom, with 170 species, *Creator* Alekseev, *Dendrocerus* Ratzeburg, with 118 species, *Megaspilus* Westwood, *Platyceraphron* Kieffer, *Trassedia* Cancemi and *Trichosteresis* Forster. Genus *Lygocerus* was synonymized with *Dendrocerus* (Dessart, 1966, 1995b). Lagynodinae subfamily has five genera: *Aetholagynodes* Dessart, *Archisynarsis* Szabo, *Holophleps* Kozlov, *Lagynodes* Forster and *Typhlolagynodes* Dessart (Kieffer, 1907; Dessart, 1966 a,b, 1972 a,b, 1977, 1981, 1987, 1995f; Masner & Dessart, 1967; Muesebeck, 1979; Dessart & Walker, 1981; Dessart & Cancemi, 1986; Masner, 1993; Broad & Livermore, 2014).

In Europe, Megaspilidae family is represented by 140 species with nine genera: *Conostigmus* (with 95 species), *Creator* (*C. spissicornis* Hellen, 1966), *Dendrocerus* (with 31 species), *Holophleps* (*H. brevigena* Kozlov, 1966), *Lagynodes* (with five species), *Megaspilus* (with two species), *Platyceraphron* (with two species), *Trichosteresis* (with two species), *Typhlolagynodes* (*T. phineus* Dessart, 1981).

Biology data

For most species from the superfamily Ceraphronoidea, the biology is still unknown. According to Dessart (1995a), some species of ceraphronoids attack hosts that live in „weak concealment”, others develop in the prepupae of certain Hymenoptera parasitoids. Whilst the Ceraphronidae contains primary ecto- and endoparasitoids, within the same genus, at least some megaspilids are known to be ectoparasitoid idiobionts. While the hosts of both ceraphronids and megaspilids

seem to be centred on Diptera there are many exceptions and the range of hosts of the superfamily spans several orders (Broad & Livermore, 2014). The hosts of the species of Ceraphronidae include especially Diptera (Cecidomyiidae) but also some Hymenoptera, Homoptera, Neuroptera, and Thysanoptera insect orders. Few species are hyperparasitoids, parasiting Braconidae (primary parasitoids on lepidopterans) or Bethyilidae (primary parasitoids on coleopterans Curculionidae) (Priesner, 1936; Pschorn-Walcher, 1956; Alekseev & Dolgin, 1984; Dessart, 1988, 1994; Pitonakova, 1989). Many species of the family Megaspilidae are primary ectoparasitoids, attacking Diptera, Neuroptera, Coleoptera, and Mecoptera. Some *Dendrocerus* species are mentioned as primary parasitoids on Diptera (Cecidomyiidae, Chamaemyiidae), Neuroptera (Chrysopidae, Coniopterygidae, Hemerobiidae) and Coleoptera (Coccinellidae). Other species of *Dendrocerus* are hyperparasitoids, which parasitize some primary parasitoids Hymenoptera (Dessart, 1995b): Aphidiidae, Charipidae, Encyrtidae, which are primary parasitoid of Homoptera Aphididae, Psyllidae, Coccidae (Bequaert, 1913; Hedicke, 1929; Dessart, 1973; Cooper & Dessart, 1975; Dessart, 1978b; Fergusson, 1980; Walker & Cameron, 1981; Dessart, 1983; Dessart & Gardenfors, 1985; Dessart, 1994; Johnson & Musetti, 2004; Mikó & Deans, 2009; Broad & Livermore, 2014). The most species are oligophagous, but some are polyphagous, e.g. *Dendrocerus carpenteri* (Curtis, 1829) that has been reared from over 70 Aphidiidae species (Fergusson, 1980).

MATERIAL AND METHODS

The material was collected from orchards, forests, crops, litter. The collection methods were different: the use of the entomological net, the Barber traps, and the examination of the aerial organs of the plants. An important number of species were obtained in laboratory, from Chamaemyiidae and Syrphidae puparia, or from aphid mummies. In laboratory conditions, many aphid colonies were isolated and analyzed.

New taxa for Romanian fauna are indicated by asterisk, one for species (*) and two for genera (**). The synonymies are indicated only in the situations in which, in previously published papers of the author or in PhD thesis of the author, some species are named under these names, in present passed as synonyms. The arrangement of the species name is alphabetical.

RESULTS AND DISCUSSION

In Romania, as a result of personal investigations, from the Ceraphronidae family were identified 21 species from three genera (*Aphanogmus*, *Ceraphron* and *Elysocheraphron*). The species are: *Aphanogmus abdominalis* (Thompson, 1858); *A. apicalis* Szelenyi, 1938; *A. bicolor* Ashmead, 1893; *A. crassiceps* (Kieffer, 1907);

A. elegantulus Forster, 1861; *A. fumipennis* Thomson, 1859 (syn. *A. formicarius* Kieffer, 1905); *A. microneurus* Kieffer, 1907; *A. rufus* Szelenyi, 1938; *A. terminalis* Forster, 1861; *Ceraphron bispinosus* (Nees, 1834); *C. brevipennis* Kieffer, 1907; *C. flavicornis* Kieffer, 1907; *C. flaviventris* Kieffer, 1907; *C. pallipes* (Thomson, 1858); *C. pristomicrops* Dessart, 1965; *C. scoticus* Kieffer, 1907; *C. serraticornis* Kieffer, 1907; *C. testaceipes* Kieffer, 1904; *C. thomsoni* Dala Tore, 1890 (syn. *C. longipennis* Kieffer, 1907); *C. trissacantha* Kieffer, 1907 and *Elysocheraphron hungaricus* Szelenyi, 1936.

A number of 20 species and two genera (*Aphanogmus* and *Elysocheraphron*) are new for the Romanian fauna (Figs. 1–3; Table 1).



Fig. 1. *Ceraphron serraticornis* Kieff. (♀). (orig.).

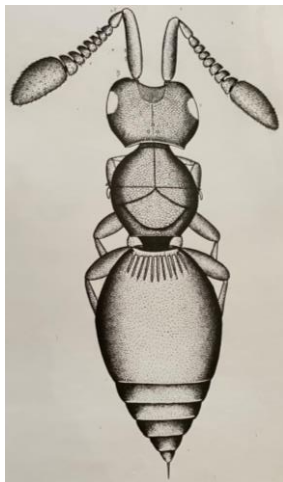


Fig. 2. *Ceraphron pristomicrops* Kieff. (♀). (orig.).



Fig. 3. *Ceraphron brevipennis* Kieff. (♀). (orig.).

Table 1

Ceraphronidae family – geographical distribution and their status in Romania

No. crt.	Species	Geographic distribution	New for Romanian fauna
<i>Aphanogmus</i> genus			**
1.	<i>Aphanogmus abdominalis</i> (Thompson, 1858)	Europe, Nearctic	*
2.	<i>Aphanogmus apicalis</i> Szelenyi, 1938	Europe	*
3.	<i>Aphanogmus bicolor</i> Ashmead, 1893	Europe, Nearctic	*
4.	<i>Aphanogmus. crassiceps</i> (Kieffer, 1907)	Europe	*
5.	<i>Aphanogmus elegantulus</i> Forster, 1861	Europe	*
6.	<i>Aphanogmus fumipennis</i> Thomson, 1859 syn. <i>Aphanogmus formicarius</i> Kieffer, 1905	Europe, Afro-tropical region, East Palaearctic Nearctic	*
7.	<i>Aphanogmus microneurus</i> Kieffer, 1907	Europe, East Palaearctic Nearctic	*
8.	<i>Aphanogmus rufus</i> Szelenyi, 1938	Europe	*
9.	<i>Aphanogmus terminalis</i> Forster, 1861	Europe	*
<i>Ceraphron</i> genus			**
10.	<i>Ceraphron bispinosus</i> (Nees von Esenbeck, 1834)	Europe, East Palaearctic Nearctic	*
11.	<i>Ceraphron brevipennis</i> Kieffer, 1907	Europe	*
12.	<i>Ceraphron flavicornis</i> Kieffer, 1907	Europe	*
13.	<i>Ceraphron flaviventris</i> Kieffer, 1907	Europe, inclusively Romania	-
14.	<i>Ceraphron pallipes</i> (Thomson, 1858)	Europe	*
15.	<i>Ceraphron pristomicrops</i> (Dessart, 1965)	Europe	*
16.	<i>Ceraphron scoticus</i> Kieffer, 1907	Europe	*
17.	<i>Ceraphron serraticornis</i> Kieffer, 1907	Europe, East Palaearctic	*
18.	<i>Ceraphron testaceipes</i> Kieffer, 1904	Europe	*
19.	<i>Ceraphron thomsoni</i> Dala Tore, 1890 syn. <i>Ceraphron longipennis</i> Kieffer, 1907)	Europe	*
20.	<i>Ceraphron trissacantha</i> Kieffer, 1907	Europe	*
<i>Elysoceraphron</i> genus			**
21.	<i>Elysoceraphron hungaricus</i> Szelenyi, 1936	Europe, East Palaearctic	*

In Romania, as a result of personal investigations, from the Megaspilidae family were identified 43 species and five genera (*Conostigmus*, *Dendrocerus*, *Lagynodes*, *Megaspilus* and *Trichosteres*), from Megaspilinae and Lagynodinae subfamilies.

Megaspilinae subfamily is represented by 39 species and four genera: *Conostigmus*, *Dendrocerus* (syn. *Lygocerus*), *Megaspilus* and *Trichosteres*. The species are: *Conostigmus abdominalis* (Boheman, 1832); *C. brachypterus* (Thomson, 1858); *C. cursitans* (Nees von Esenbeck, 1834); *C. dimidiatus* (Thomson, 1859); *C. fasciatipennis* Kieffer, 1907; *C. flavipes* (Zetterstedt, 1840); *C. formiceti* (Erichson, 1844); *C. frontalis* (Thomson, 1858); *C. gestroi* Kieffer, 1907; *C. halteratus* (Boheman, 1832); *C. lativentris* (Thomson, 1858) - syn.

C. scabriventris Kieffer, 1907; *C. levifrons* Kieffer, 1907; *C. multicolor* Kieffer, 1907; *C. pubescens* (Thomson, 1858); *C. ruficollis* Kieffer, 1907; *C. rufipes* (Nees von Esenbeck, 1834); *C. singularis* Alekseev, 1983; *C. subspinosus* Kieffer, 1907; *C. triangularis* Thomson, 1858; *Dendrocerus antennalis* (Kieffer, 1907) – syn. *Lygocerus antennalis* Kieffer, 1907; *D. aphidum* (Rondani, 1877) – syn. *Lygocerus bicolor* Kieffer, 1907, *L. neglectus* (Kieffer, 1907); *D. basalis* (Thomson, 1859); *D. bispinosus* (Kieffer, 1907); *D. carpenteri* (Curtis, 1829) – syn. *Lygocerus campestris* (Kieffer, 1907), *L. aphidivorus* (Kieffer, 1907), *L. testaceimanus* Kieffer, 1907; *D. halidayi* (Curtis, 1829); *D. laevis* (Ratzeburg, 1852) – syn. *Lygocerus frontalis* (Thomson, 1858); *D. laticeps* (Hedicke, 1929); *D. punctipes* (Boheman, 1832); *D. pupparum* (Boheman, 1832); *D. ramicornis* (Boheman, 1832); *D. rectangularis* (Kieffer, 1907) – syn. *Lygocerus claripennis* Kieffer, 1907; *D. remaudierei* Dessart, 1974; *D. serricornis* (Boheman, 1832) – syn. *Lygocerus piceae* Kieffer, 1907a; *Megaspilus dux* (Curtis, 1829); *M. striolatus* (Thomson, 1859); *M. bispinosus* Kieffer, 1907 and *Trichosteresis glabra* (Boheman, 1832) – syn. *T. syrphii* (Bouche, 1834).

Lagynodinae subfamily is represented by *Lagynodes acuticornis* (Kieffer, 1906) - syn. *Plastomicrops acuticornis* Kieffer, 1906; *Lagynodes biroi* Szelenyi, 1936; *Lagynodes pallidus* (Boheman, 1832) and *Lagynodes thoracicus* Kieffer, 1906.

A number of 39 species and three genera (*Dendrocerus*, *Megaspilus* and *Trichosteresis*) are new for the Romanian fauna (Figs. 4–8; Table 2).



Fig. 4. *Conostigmus scabriventris* Kieff. (♀). (orig.).

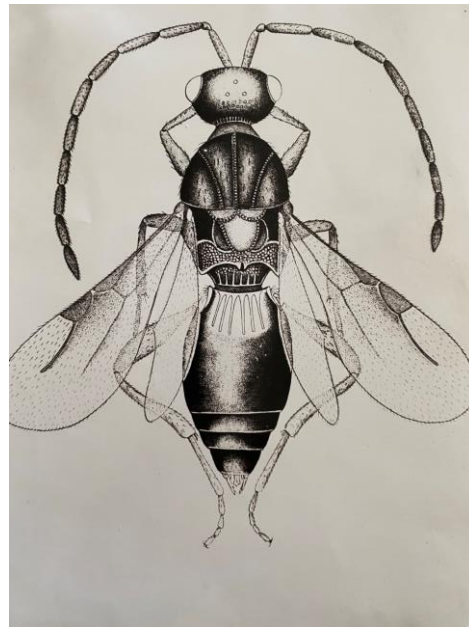


Fig. 5. *Megaspilus bispinosus* Kieff. (♂). (orig.).



Fig. 6. *Dendrocerus serricornis* (♂)
in puparium of *Neoleucopis obscura* (orig.).

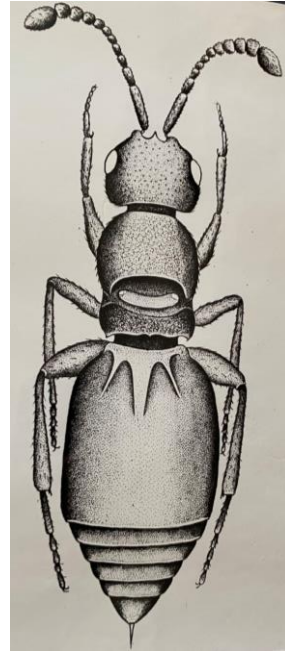


Fig. 7. *Lagynodes pallidus* (Boh.) (♀). (orig.).



Fig. 8. *Lagynodes thoracicus* Kieff. (♀). (orig.).

Table 2

Megaspilidae species – geographic distribution and their status in Romania

No crt.	Megaspilidae subfamilies, genera and species	Geographic distribution	New for Romanian fauna
	MEGASPILINAE SUBFAMILY		-
	<i>Conostigmus</i> genus		-
1.	<i>Conostigmus abdominalis</i> (Boheman, 1832)	Europe	*
2.	<i>Conostigmus brachypterus</i> (Thomson, 1858)	Europe	*
3.	<i>Conostigmus cursitans</i> (Nees von Esenbeck, 1834)	Europe, East Palearctic	*
4.	<i>Conostigmus dimidiatus</i> (Thomson, 1859)	Europe, East Palearctic	*
5.	<i>Conostigmus fasciatipennis</i> Kieffer, 1907	Europe	*
6.	<i>Conostigmus flavipes</i> (Zetterstedt, 1840)	Europe	*
7.	<i>Conostigmus formiceti</i> (Erichson, 1844)	Europe	*
8.	<i>Conostigmus frontalis</i> (Thomson, 1858)	Europe	*
9.	<i>Conostigmus gestroi</i> Kieffer, 1907	Europe	*
10.	<i>Conostigmus halteratus</i> (Boheman, 1832)	Europe	*
11.	<i>Conostigmus lativentris</i> (Thomson, 1858) syn. <i>C. scabriventris</i> Kieffer, 1907	Europe	*
12.	<i>Conostigmus levifrons</i> Kieffer, 1907	Europe	*
13.	<i>Conostigmus multicolor</i> Kieffer, 1907	Europe	*
14.	<i>Conostigmus pubescens</i> (Thomson, 1858)	Europe	*
15.	<i>Conostigmus ruficollis</i> Kieffer, 1907	Europe	*
16.	<i>Conostigmus rufipes</i> (Nees von Esenbeck, 1834)	Europe	*
17.	<i>Conostigmus singularius</i> Alekseev, 1983	Europe	*
18.	<i>Conostigmus subspinosus</i> Kieffer, 1907	Europe	*
19.	<i>Conostigmus triangularis</i> Thomson, 1858	Europe	*
	<i>Dendrocerus</i> genus (syn. <i>Lygocerus</i>)		**
20.	<i>Dendrocerus antennalis</i> (Kieffer, 1907) syn. <i>Lygocerus antennalis</i> Kieffer, 1907	Europe	*
21.	<i>Dendrocerus aphidum</i> (Rondani, 1877) syn. <i>Lygocerus bicolor</i> Kieffer, 1907 <i>L. neglectus</i> (Kieffer, 1907) <i>L. rufipes</i> Thomson, 1858	Europe, East Palearctic Nearctic, North Africa	*
22.	<i>Dendrocerus basalis</i> (Thomson, 1859)	Europe, East Palearctic	*
23.	<i>Dendrocerus bifoveatus</i> (Kieffer)	Europe, East Palearctic	*
24.	<i>Dendrocerus bispinosus</i> (Kieffer, 1907)	Europe	*
25.	<i>Dendrocerus carpenteri</i> (Curtis, 1829) syn. <i>Lygocerus aphidivorus</i> (Kieffer, 1907) <i>L. campestris</i> (Kieffer, 1907) <i>L. testaceimanus</i> Kieffer, 1907	Cosmopolitan	*
26.	<i>Dendrocerus flavipes</i> Kieffer, 1907	Europe, East Palaeartic	*
27.	<i>Dendrocerus halidayi</i> (Curtis, 1829)	Europe, East Palaeartic	*
28.	<i>Dendrocerus laevis</i> (Ratzeburg, 1852) syn. <i>Ceraphron frontalis</i> (Thomson, 1858)	Europe, East Palaeartic North Africa	*
29.	<i>Dendrocerus laticeps</i> (Hedicke, 1929)	Europe, East Palaeartic Nearctic	*

Table 2 (continued)

No crt.	Megaspilidae subfamilies, genera and species	Geographic distribution	New for Romanian fauna
30.	<i>Dendrocerus punctipes</i> (Boheman, 1832)	Europe, North Africa	*
31.	<i>Dendrocerus pupparum</i> (Boheman, 1832)	Europe, East Palearctic Nearctic, North Africa	*
32.	<i>Dendrocerus ramicornis</i> (Boheman, 832)	Europe, East Palearctic	*
33.	<i>Dendrocerus rectangularis</i> (Kieffer, 1907) syn. <i>Lygocerus claripennis</i> Kieffer, 1907	Europe, East Palearctic Nearctic	*
34.	<i>Dendrocerus remaudierei</i> Dessart, 1974	Europe, Nearctic	*
35.	<i>Dendrocerus serricornis</i> (Boheman, 1832) syn. <i>Lygocerus piceae</i> Kieffer, 1907a	Europe, Nearctic	*
	<i>Megaspilus</i> genus		**
36.	<i>Megaspilus bispinosus</i> Kieffer, 1907	Europe, East Palearctic	*
37.	<i>Megaspilus dux</i> (Curtis, 1829)	Europe, East Palearctic	*
38.	<i>Megaspilus striolatus</i> (Thomson, 1859)	Europe, East Palearctic	*
	<i>Trichosteresis</i> genus		**
39.	<i>Trichosteresis glabra</i> (Boheman, 1832) syn. <i>Trichosteresis syrphii</i> (Bouche, 1834)	Europe, East Palearctic, Nearctic	*
	LAGYNODINAE SUBFAMILY		-
	<i>Lagynodes</i> genus		-
40.	<i>Lagynodes acuticornis</i> (Kieffer, 1906) syn. <i>Plastomicrops acuticornis</i> Kieffer, 1906	Holarctic	-
41.	<i>Lagynodes biroi</i> Szelenyi, 1936	Europe	-
42.	<i>Lagynodes pallidus</i> (Boheman, 1832)	Europe, Nearctic, Probably cosmopolitan	-
43.	<i>Lagynodes thoracicus</i> Kieffer, 1906	Europe	-

The author's contribution is found in 41 scientific papers, of which 21 are as single author, six as first author, the remaining 14 being works made in collaboration (Teodorescu, 1967, 1970, 1971, 1972, 1973 a,b,c,d, 1974, 1975 a,b, 1980, 1982, 1983, 1986 a,b, 1991, 2001, 2008 a,b, 2009; Ionescu & Teodorescu, 1969; Ionescu *et al.*, 1972; Ceianu & Teodorescu, 1973, 1975; Mustață *et al.*, 1977; Lăcătușu *et al.*, 1978, 1979, 1980, 1981, 1983 a,b, 1984, 1985, 1986; Teodorescu & Mustață, 1980; Teodorescu & Ceianu, 1981; Teodorescu *et al.*, 1990; Teodorescu & Vădineanu, 2001; Teodorescu & Antonie, 2007–2008; Teodorescu & Maican, 2014).

In the PhD thesis of author (*Contributions to study of morphology, biology and zoogeography of Ceraphronoidea and Proctotrupoidea (Insecta - Hymenoptera) from Romania*, vol. I = 470 pages and vol. II, album with 99 pages and 316 original figures) from total 154 species, 38 are Ceraphronoidea, 35 species and *Aphanogmus*, *Dendrocerus*, *Megaspilus* and *Trichosteresis* genera being new in Romanian fauna (Teodorescu Irina, 1973d).

Regarding the role of species of *Dendrocerus* as hyperparasitoids and primary parasitoids, in the control of populations and in the natural balance some comments can be made (Tables 3–4).

Table 3

Dendrocerus – hyperparasitoids in Romania (from the autor data)

No crt.	<i>Dendrocerus</i> – secondary parasitoids	Aphidiidae – primary parasitoids	Aphidiidae – hosts for primary parasitoids
1	<i>Dendrocerus antennalis</i> (Kieffer, 1907) syn. <i>Lygocerus antennalis</i> Kieffer, 1907	<i>Ephedrus lacertosus</i> , <i>E. plagiator</i> <i>Lipolexis gracilis</i>	<i>Brachycaudus cardui</i> <i>Hyalopterus pruni</i>
2	<i>Dendrocerus aphidum</i> (Rondani, 1877) syn. <i>Lygocerus bicolor</i> Kieffer, 1907, <i>L. neglectus</i> (Kieffer, 1907), <i>L. rufipes</i> Thomson, 1858	<i>Aphidius avenae</i> , <i>A. persicae</i> , <i>Diaeretiella rapae</i> , <i>Ephedrus lacertosus</i> , <i>E. plagiator</i> , <i>Lipolexis gracilis</i> , <i>Lysiphlebus fabarum</i> , <i>Praon dorsale</i> , <i>P. myzophagum</i> , <i>P. volucre</i> , <i>Trioxys cirsi</i> , <i>T. humuli</i>	<i>Acyrtosiphon onobrychis</i> , <i>Aphis fabae</i> , <i>A. gossypii</i> , <i>Brachycaudus cardui</i> , <i>Brevicoryne brassicae</i> , <i>Hyalopterus pruni</i> , <i>Myzus persicae</i> , <i>Phorodon humuli</i> , <i>Rhopalosiphum maydis</i> , <i>Sitobion avenae</i>
3	<i>Dendrocerus carpenteri</i> (Curtis, 1829) syn. <i>Lygocerus aphidivorus</i> (Kieffer, 1907, <i>L. campestris</i> (Kieffer, 1907), <i>L. testaceimanus</i> Kieffer, 1907	<i>Aclitus obscuripennis</i> , <i>Aphidius avenae</i> , <i>A. ervi</i> , <i>A. granarius</i> , <i>A. rosae</i> , <i>A. matricariae</i> , <i>A. picipes</i> , <i>Diaeretiella rapae</i> , <i>Ephedrus crassicola</i> , <i>E. lacertosus</i> , <i>E. plagiator</i> , <i>Lipolexis gracilis</i> , <i>Lysiphlebus ambiguous</i> , <i>L. fabarum</i> , <i>L. testaceipes</i> <i>Monoctonus nervosus</i> , <i>Praon dorsale</i> , <i>P. flavinode</i> , <i>P. volucre</i> , <i>Trioxys angelicae</i> , <i>T. humuli</i>	<i>Aphis fabae</i> <i>Acyrtosiphon onobrychis</i> <i>A. pisum</i> , <i>Dysaphis apiifolia</i> , <i>Brachycaudus cardui</i> , <i>Brevicoryne brassicae</i> , <i>Hyalopterus pruni</i> , <i>Macrosiphum euphorbiae</i> , <i>M. rosae</i> , <i>M. solani</i> , <i>Myzus cerasi</i> , <i>M. persicae</i> , <i>Phorodon humuli</i> , <i>Rhopalosiphum maydis</i> , <i>R. nymphaea</i> , <i>Schizaphis graminum</i> , <i>Sitobion avenae</i>
4	<i>Dendrocerus laevis</i> (Ratzeburg, 1852) syn. <i>Ceraphron frontalis</i> (Thomson, 1858)	<i>Aphidius avenae</i> , <i>Lysiphlebus fabarum</i> , <i>Praon volucre</i>	<i>Hyalopterus pruni</i> , <i>Rhopalosiphum maydis</i> , <i>Sitobion avenae</i>
5	<i>Dendrocerus laticeps</i> (Hedicke, 1929)	<i>Aphidius</i> sp., <i>Diaeretiella rapae</i> , <i>Praon</i> sp., <i>Trioxys</i> sp.	<i>Aphis pomi</i> , <i>Brevicoryne brassicae</i>
6	<i>Dendrocerus rectangularis</i> (Kieffer, 1907) syn. <i>Lygocerus claripennis</i> Kieffer, 1907	<i>Aphidius avenae</i> , <i>A. granarius</i>	<i>Rhopalosiphum nymphaea</i> , <i>Schizaphis graminum</i> , <i>Sitobion avenae</i>

Table 4

Dendrocerus – primary parasitoids in Romania (from the autor data)

No crt.	<i>Dendrocerus</i> – primary parasitoids	Hosts for <i>Dendrocerus</i> – primary parasitoid	Homoptera colonies
		Diptera Syrphidae	Homoptera Aphididae
1	<i>Dendrocerus pupparum</i> (Boheman, 1832)	<i>Episyrphus balteatus</i> <i>Metasyrphus corollae</i> <i>Syrphus ribesii</i>	<i>Brevicoryne brassicae</i> <i>Myzus persicae</i>
2	<i>Trichosteresis glabra</i> (Boheman, 1832) syn. <i>Trichosteresis syrphii</i> (Bouche, 1834)	<i>Episyrphus balteatus</i> <i>Melanostoma mellinum</i> <i>Metasyrphus corollae</i> <i>Syrphus ribesii</i>	<i>Brevicoryne brassicae</i> <i>Myzus persicae</i> <i>Hyalopterus pruni</i>
		Diptera Chamaemyiidae	Homoptera Adelgidae
3	<i>Dendrocerus serricornis</i> (Boheman, 1832) syn. <i>Lygocerus piceae</i> Kieff, 1907	<i>Neoleucopis obscura</i>	<i>Dreyfusia piceae</i>
		Diptera Cremifaniidae	Homoptera Adelgidae
4	<i>Dendrocerus serricornis</i> (Boheman, 1832) syn. <i>Lygocerus piceae</i> Kieff, 1907	<i>Cremifania nigrocellulata</i>	<i>Dreyfusia piceae</i> <i>Pineus pini</i>
		Neuroptera	Homoptera Adelgidae
5	<i>Dendrocerus halidayi</i> (Curtis, 1829)	? Coniopterygidae	<i>Dreyfusia piceae</i>

To obtain some data on the hosts of *Dendrocerus* species, more than 30 colonies of aphid species were isolated and controlled in laboratory, some of them for several consecutive years: *Acyrtosiphon onobrychis*, *A. pisum*, *Aphis fabae*, *A. gossypii*, *A. pomi*, *Brachycaudus cardui*, *Brevicoryne brassicae*, *Dysaphis apiifolia*, *Hyalopterus pruni*, *Macrosphum euphorbiae*, *M. rosae*, *M. solani*, *Myzus cerasi*, *M. persicae*, *Pergandeida robiniae*, *Phorodon humuli*, *Rhopalosiphum maydis*, *R. nymphaea*, *Sappaphis pyri*, *Schizaphis graminum*, *Sitobion avenae*, *Stomaphis bobretzkyi* etc.

In many cases, all the components of the characteristic trophic network were discovered in these aphids colonies: numerous predators (Cecidomyiidae, Chamaemyiidae, Chrysopidae, Coccinellidae and Syrphidae) and parasitoids (Aphidiidae, Encyrtidae, Megaspilidae, Pteromalidae) (Ionescu *et al.*, 1972; Teodorescu, 1973 b,c; Ceianu & Teodorescu, 1973, 1975; Mustață *et al.*, 1977; Lăcătușu *et al.*, 1978, 1980, 1981, 1983 a,b, 1984, 1986; Teodorescu, 1973 d; Teodorescu, 1986 b, 1991, 2008 a,b; Teodorescu & Mustață, 1980; Teodorescu & Ceianu, 1981).

A number of 24 species of Aphidiidae are reported as primary parasitoids in the colonies of these aphids: *Aclitus obscuripennis*, *Aphidius avenae*, *A. ervi*, *A. granarius*, *A. matricariae*, *A. persicae*, *A. picipes*, *A. rosae*, *Diaeretiella rapae*, *Ephedrus crassicola*, *E. lacertosus*, *E. plagiator*, *Lipolexis gracilis*, *Lysiphlebus ambiguous*, *L. fabarum*, *L. testaceipes*, *Monoctonus nervosus*, *Praon dorsale*, *P. flavinode*, *P. myzophagum*, *P. volucre*, *Trioxys angelicae*, *T. cirsii*, *T. humuli*. The most of species were determined by Matilda Lăcătușu.

Regarding the new families of Diptera (Chamaemyiidae and Cremifaniidae) as hosts for *Dendrocerus serricornis*, two cases can be discussed, with the mention of the fact that I also studied Chamaemyiidae from Romania was an advantage.

In the paper “*Dendrocerus (Macrostigma) serricornis* (Boh.), parasitoid on Chamaemyiid *Neoleucopis obscura* Hall., predator in colonies of *Dreyfusia piceae* Ratz. (Homoptera Adelgidae)” (in Romanian), the authors report that per 1 square meter of bark of *Abies nordmanniana* Spach., with a very strong attack of *Dreyfusia*, were counted 386 adults and 463 *Neoleucopis* puparia. From a very rich material, brought to the laboratory, numerous predators (Coccinellidae, Chrysopidae, Cecidomyiidae, Syrphidae and Chamaemyiidae) and parasitoids (Encyrtidae, Megaspilidae and Pteromalidae) were obtained. All of these are presumptive components of a trophic network in which *Dendrocerus* also falls. A total of 435 *Neoleucopis obscura* adults emerged from puparia, and 509 empty or dead pupae and dead larvae were counted. Of the parasitoid *Dendrocerus serricornis* only 42 specimens (18 males and 24 females) were obtained. Both *Neoleucopis obscura* and *Dendrocerus serricornis* were new to Romania's fauna, as a genus and species (Ceianu & Teodorescu Irina, 1973).

In the paper “Subfamily Cremifaniinae (Diptera-Chamaemyiidae) new for the Romanian fauna” (in Romanian), the authors present the species *Cremifania nigrocellulata* Czerny, 1904, the genus *Cremifania* and the subfamily Cremifaniinae as new for Romania. The subfamily Cremifaniinae is now considered the family Cremifaniidae. The species was detected in the colonies of *Dreyfusia piceae* on *Abies alba* and in the colonies of *Pineus pini* (new host for science) on *Pinus nigra*. For *Dendrocerus serricornis*, *Cremifania nigrocellulata* is the new host for science (Teodorescu Irina & Ceianu, 1981).

We paid attention to the analysis of these interrelationships between the larvae of the species of *Dendrocerus* and their hosts, either with Hymenoptera Aphidiidae (as hyperparasitoids) or with the larvae of the aphidophagous species of Diptera, Coleoptera and Neuroptera (as primary parasitoids).

In the interrelations between Aphididae (Homoptera) and a series of species of parasitoids or predators, it is found the existence of a true trophic network. It should be noted that in the interrelationships with the parasitoids and predators

are involved the preimaginal stages (the larvae), because, like all species of parasitoids, only the larval stage lives as a parasite of other species, adults have free life and consume nectar.

In the trophic networks which include the larvae of species of *Dendrocerus*, the primary producers are the plants, and all the species of Homoptera, Hymenoptera, Diptera, Neuroptera and Coleoptera belong to the category of consumers (Fig. 9). The species of Homoptera being phytophagous are primary consumers. The larvae of Aphidiidae and Aphelinidae are the secondary consumers (parasitoids on Aphididae, Coccoidea, other homopterans, so that are the primary parasitoids). The larvae of Charipidae, Encyrtidae and some *Dendrocerus* species are the tertiary consumers (parasitoids on Aphidiidae, so that are the secondary parasitoids). The larvae of Pteromalidae are the quaternary consumers (parasitoids on Charipidae, Encyrtidae, sometimes on Aphidiidae, so that are the tertiary parasitoids, sometimes the secondary). As parasitoids of other species of parasitoids, secondary and tertiary parasitoids are called hyperparasitoids. Because trophic resources are limited („provided” by a homopter specimen), it is considered that in this trophic pyramid, only three categories of parasitoids (primary, secondary and tertiary) can be instaled, corresponding to the three categories of consumers (secondary, tertiary and quaternary). The larva of Aphidiidae initially has a slow development, the host aphid continues to feed and grow, and finally, the parasitoid's larva quickly reaches full development, killing its host and turning into a pupa stage. This pupa of the primary parasitoid remains protected by the swollen body of the aphid, with dried cuticula (which is named aphid *mummy*). Aphidiidae pupae can be attacked by the larvae of some hyperparasitoid species, either by Alloxystinae (Cynipoidea, Charipidae), *Syrphophagus* (Encyrtidae), *Dendrocerus* (Ceraphronoidea, Megaspilidae) or even by some Pteromalidae, in the absence of Charipidae or Encyrtidae species. The strategies of these secondary parasitoids are different. The larvae of Charipidae Alloxystinae and Encyrtidae are koinobiont, endoparasitoids in the larvae of Aphidiidae, when the aphids are still alive, before mummification. *Dendrocerus* larvae are ectoparasitoids, idiobionts, which approach from the outside the prepupae or pupae of Aphidiidae that live inside the Aphididae mummy (Buitenhuis *et al.*, 2017).

As parasitoid on Aphidiidae primary parasitoid some *Dendrocerus* species are hyperparasitoids.

In the colonies of some Homoptera (Aphididae, Adelgidae, Coccidae), the larvae of other *Dendrocerus* species, as primary parasitoids, has new target host species: larvae/pupae of some predatory species (Diptera: Chamaemyiidae, Cremifaniidae, Cecidomyiidae, Syrphidae, Neuroptera: Chrysopidae, Coniopterygidae, Hemerobiidae, Coleoptera: Coccinellidae). *Dendrocerus* adults appear from the pupae or cocoons of these aphidophagous predators.

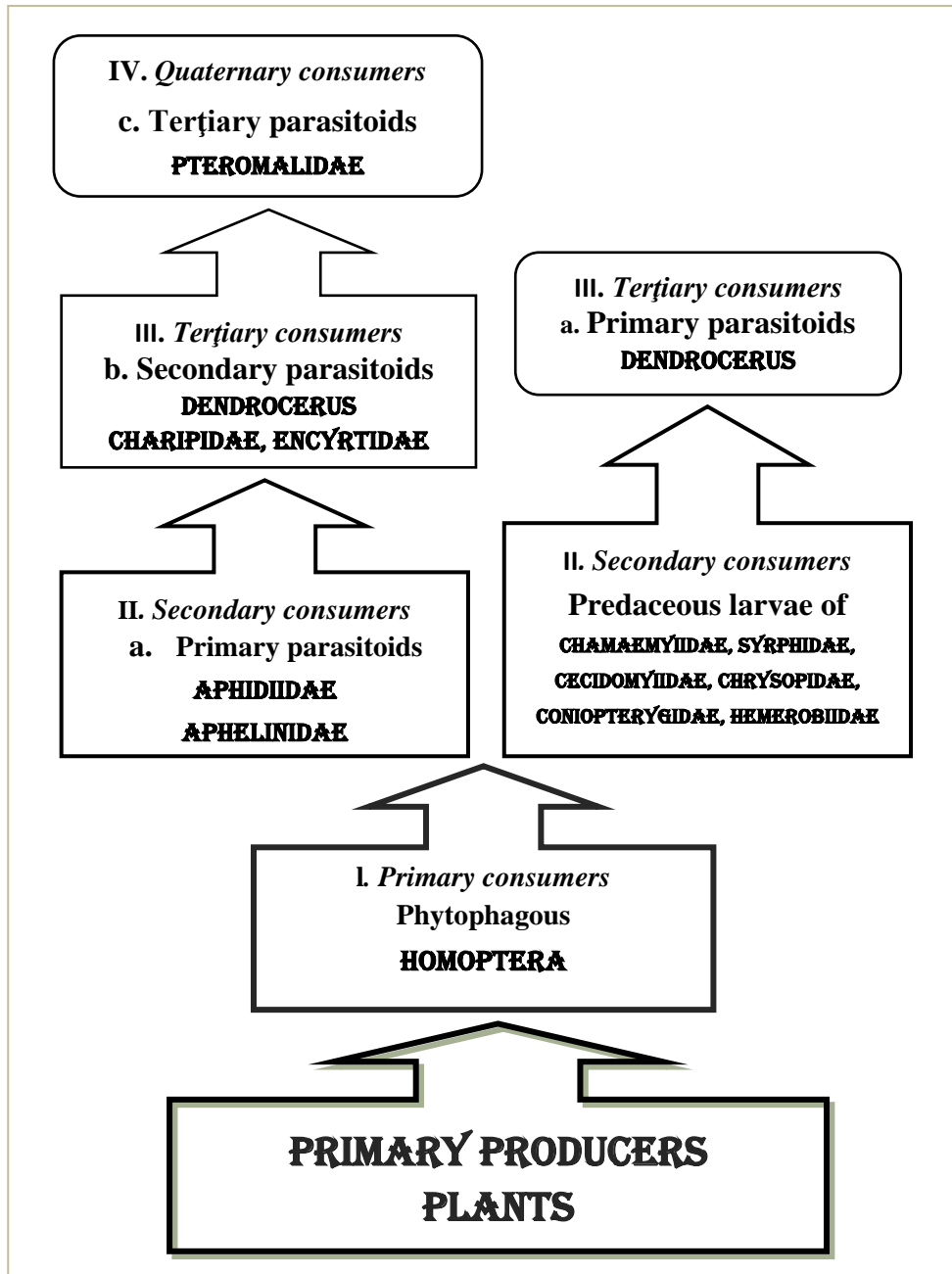


Fig. 9. Trophic categories: producers, consumers (primary, secondary, tertiary and quaternary) and parasitoid categories (primary, secondary and tertiary) in Homoptera colonies (The arrows direction correspond with the matter circulation direction, from consumed nourishment to consumer).

The negative or positive action of *Dendrocerus* species in relations with some Homoptera must be analyzed according to their involvement in the two types of trophic networks.

In a trophic network with plants as primary producers – Homoptera Aphididae as phytophagous – species of Aphidiidae as primary parasitoids - some species of *Dendrocerus* as secondary parasitoids = hyperparasitoids, these species of *Dendrocerus* appear to be favorable to species of phytophagous Homoptera (as killers of their primary parasitoids) and with a negative action on both primary parasitoids and host plants.

In another trophic network (plants - Homoptera Aphididae as phytophagous – larvae/pupae of some predatory species of Chamaemyiidae, Cecidomyiidae, Syrphidae, Chrysopidae, Coniopterygidae, Hemerobiidae – other species of *Dendrocerus* as primary parasitoids, these species of *Dendrocerus* can appear with the same positive role for phytophagous Homoptera (as killers of their predatory species), and with negative role, both for the predaceous species and for plants.

The two scenarios may be possible in the cases with higher levels of hyperparasitism, a rarity in nature, but frequently in special installations for reared some beneficial species, due to the accidental introduction either of hyperparasitoid species or of some primary parasitoids of the predatory species.

The role of *Dendrocerus* species may appear as negative, if the interrelationships are analyzed at the level of the individuals involved, but in reality, at the level of populations and biocoenosis, their role is positive. Their role in the complexity of biocenosis interrelationships must be considered, in order to maintain a balance between producers and different categories of consumers, in order to ensure a natural control of populations. Indeed, in nature, these species, like all trophic categories, are factors of the natural biological control (in which each species controls other species and is controlled by other species). The control mechanisms are a result of the co-evolution of species and of the natural selection.

These relationships have implications and from the point of view of human interest. The human goal is to achieve a minimal impact of pests, a maximum action of primary parasitoids and predators and to increase primary production in anthropogenic ecosystems. From a human point of view, it is important to promote and implement measures to ensure and maintain a balance among the various trophic categories, with careful management of interventions in the complex interrelationships from biocoenosis.

The levels of pest species density and damages must be controlled by non-polluting methods, in order not to affect the existing trophic networks, even hyperparasitoids having an important role in maintaining the natural balance (Teodorescu & Vădineanu, 2001).

CONCLUSIONS

The previous list of Ceraphronidae and Megaspilidae species from Romania, included in the PhD thesis and in some published papers, was completed with new species collected in recent years and with new identified hosts.

In the paper are presented 64 species (21 Ceraphronidae and 43 Megaspilidae), of which 59 species (20 Ceraphronidae and 39 Megaspilidae) and five genera (two Ceraphronidae and three Megaspilidae) are new to the Romanian fauna.

Several issues regarding the role of hyperparasitoid and primary parasitoid species of *Dendrocerus* (valid for all parasitoids), in the trophic networks from the biocoenoses and in the natural balance were discussed.

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