

Braconid parasitoids (Hymenoptera: Braconidae) on poplars and aspen (*Populus* spp.) in Serbia and Montenegro

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Abstract. This is the first report of the trophic associations of Braconidae on pest insects on poplars in Serbia and Montenegro. Fifty-two braconid species from 29 genera, classified into 12 subfamilies are reported. We have recorded 58 hosts, mainly holometabolous insects from Coleoptera, Diptera, Hymenoptera and Lepidoptera, and Hemiptera as a hemimetabolous order, found on 12 poplar taxa. The total number of tritrophic associations is 114.

Key words: Braconidae, tritrophic associations, pests, southeastern Europe.

Introduction

As an important group of natural enemies, Braconidae represents one of the major groups of parasitoids attacking other insects, usually in their larval stage, but also eggs and adults (e.g. Alford 1968, Shaw & Huddleston 1991, Kavallieratos et al. 2004, Yang et al. 2008). Their role in control of other insects is based on the fact that they obligatorily kill their hosts, whether they are ecto- or endoparasitoids. Biological control of pests by braconid wasps is applicable in crop fields but also in non-arable ecosystems such as meadows and forests (Enkhbat et al. 1997, Walker & Welter 2004). Braconidae, especially the subfamily Aphidiinae, have been frequently investigated by domestic authors in southeastern Europe in the last few years (Kavallieratos et al. 2004, Žikić et al. 2009, 2010a,b, 2011, 2012a, Tomanović et al. 2006, 2009a,b, Petrović et al. 2010, 2011). Other relevant data of braconid wasps attacking host insects on poplars and aspen in Serbia and Montenegro have been published (Papp 1973, 1977, 2003, Brajković 1989, Brajković et al. 1991, 1994, Žikić et al. 2000, 2010a, 2012b, Belokobylskij & Žikić 2009, Stanković et al. 2010). Many species of the important plant family Populaceae are attacked by various pest insects such as dipteran, coleopteran, lepidopteran and hymenopteran species (Tobias 1976, Georgiev & Samuelian 1999, Georgiev 2000a,b, 2001b, 2006, Georgiev & Beshkov 2000, Ćurčić et al. 2003, Georgiev et al. 2004a,b), as well as aphids (Tomanović et al. 2006, 2009a). Damage inflicted by feeding on these plants reduces growth, which is especially important in cultivated poplar trees in

Pannonian lowland that serves to decrease strong wind in that area. In this region of Europe, which encompasses Serbia, Hungary and Romania, various herbivorous or xylophagous insects directly attack leaves, bark or roots of poplar trees, and sometimes destroy whole plantations of saplings. One important pest control programs on poplars has been conducted by Ceianu & Radoi (1971) in Romania against *Cryptorhynchus lapathi* and *Paranthrene tabaniformis*. On the other hand, indirect damage is often caused by aphids, which are the well-known transmitters of plant viruses and phytoplasmas (Dreistadt et al. 1994). Organophosphorous insecticides were extensively used for control of pest insects in these regions (Moura et al. 2006, Hummel et al. 2002). Overuse of those products was followed by appearance of resistant genotypes of pests and caused further problems to the environment, such as disruptions in food chains and suppression of natural enemies (Soares et al. 2006, Furk & Hines 1993, Dinham & Malik 2003, Alavanja et al. 2004, Scorsetti et al. 2007, Al-Deghairi 2008). More recent investigations of braconids on poplars have been provided worldwide, e.g. in Iran on willows and poplars (Rakhshani et al. 2007), in Japan by *Monoctonia vesicarii* on *Populus maximowiczii* (Takada et al. 2010), in Spain by *Pseudorhaconotus enervatus* in poplar forest (van Achterberg & Shaw 2010), and in India by *Euaphidius cingulatus* on *P. citiata* (Akhtar et al. 2011).

In this paper, we assembled all available data about the trophic relations between poplars, their pests and the braconid parasitoids in Serbia and Montenegro.

Material and methods

Flying adult wasps were collected by sweep net and Malaise trap. Mummified host larvae were placed separately in small plastic boxes with perforated covers to ensure ventilation. Colonies of living and mummified aphids sampled from the same plant individual were placed in groups in plastic boxes covered by textile tissue. All plastic boxes were put inside a growth cabinet under condition of 22.5 °C, 65% relative humidity, 16:8 light : dark photoperiod.

The major part of the data has been extracted from available literature that refers to pests on poplars and to their parasitoids in the family Braconidae in southeastern Europe, mostly in Serbia. Additional data for hosts were taken from Petrović-Obradović (2003), Jendek & Grebennikov (2009), Pil (2005), Pil & Stojanović (2007, 2009), Ilić (2005), Gnjatović & Žikić (2010) and Rakhshani et al. (2012).

Nomenclature, distribution and host data were completed according to the web site Fauna Europaea (van Achterberg 2004) and the Taxapad software package (Yu et al. 2005) with some modifications (van Achterberg, pers. comm.). For each parasitoid species and the literature sources of the hosts, appropriate data are given after they are listed. Original records by authors are marked by an asterisk (*). Samples of the subfamily Aphidiinae are deposited at the Faculty of Biology, University of Belgrade, Serbia, while specimens belonging to the rest of braconid subfamilies are deposited at the Faculty of Sciences and Mathematics, Department of Biology and Ecology, University of Niš, Serbia.

Results

We registered 52 braconid species from 29 genera in Serbia and Montenegro that are classified into 12 subfamilies: Agathidinae (1), Alysiinae (1), Aphidiinae (4), Braconinae (14), Charmontinae (1), Doryctinae (6), Exothecinae (2), Macrocentrinae (1), Microgastrinae (10), Opiinae (2), Orgilinae (1) and Rogadinae (9). Subfamilies, genera and species of the family Braconidae are listed alphabetically, along with their hosts in association with poplars in southeastern Europe. In the following part, we present all findings and data for braconid parasitoids on poplars and aspen, known on the Balkan Peninsula, including host-parasitoid associations for the investigated area. Host-plant relations were given in the Tables 1 and 2; Table 1 contains data for members of insect orders Coleoptera, Diptera, Hemiptera, and Hymenoptera, whereas Table 2 contains only species of Lepidoptera. Trophic associations (plant-host-parasitoid) were presented on autochthonic species, *Populus alba*, *P. nigra* and *P. tremula* in Serbia, as well as on

introduced species, *P. deltoides*, *P. balsamifera*, *P. grandidentata*, *P. robusta*, *P. simonii*, *P. tremuloides*, *Populus x berolinensis* and *Populus x euramericana*.

The list of trophic associations:

Subfamily Agathidinae

Therophilus tumidulus (Nees 1912)* Serbia: 1♂, Merošina: Dudulajce, ex *Gypsonoma aceriana* on *P. tremula*, 13.07.1988, Leg. M. Brajković; 1♂, 1♀, Sićevo gorge, on *P. alba*, 16.09.1997; 1♀, 12.08.1998, Leg. V. Žikić. Hosts: *Gypsonoma aceriana* on *Populus x euramericana*, (Georgiev & Delkov 2003), on *Populus* spp. (Georgiev & Samuelian 1999, Yu et al. 2005). Distribution: Austria, Belarus, Belgium, Bulgaria, Corsica, Crete, Czech Republic, Great Britain, Finland, Germany, Greece, Hungary, Ireland, Italy, Kaliningrad Region, Latvia, Lithuania, Malta, Moldova, Norway, Poland, Portugal, Romania, Russia (central, east, northwest), Sardinia, Serbia, Slovakia, Spain, Sweden, Switzerland, The Netherlands, Turkey (European part), Ukraine, Afrotropical region, Nearctic region.

Subfamily Alysiinae

Chorebus albipes (Haliday 1839)* Serbia: 2♀, Sićevo gorge: Ostrovica, 05.05.1996; 1♂, 1♀, 15.08.1996; 1♀, 27.07.1997; 3♀, Niš: Prosek, 10.07.1996; 1♀, ex *Paraphytomyza populi* on *P. alba*, Sićevo gorge: Sićevo, 15.08.1995; 1♂, on *P. alba*, 28.06.1996; 2♀, 14.10.1996; 1♀, 25.08.1997; 1♂, on *P. nigra*, Sićevo gorge: Pasjača, 23.09.1996; 1♀, Niš, 18.05.1996, Leg. V. Žikić. Hosts: *Paraphytomyza populi* on *Populus alba*, *P. nigra* and *P. tremula*; *Aulagromyza tremulae* on *Populus nigra*, *P. x berolinensis* and *P. tremula* (Georgiev & Boyadzhiev 2002). Distribution: Bulgaria, Denmark, Germany, Great Britain, Hungary, Ireland, Poland, Russia (central), Serbia, Spain, Sweden, The Netherlands, Ukraine.

Subfamily Aphidiinae

Adialytus salicaphis (Fitch 1855)* Serbia: 6♂, 29♀, Mt Beljanica, ex *Chaitophorus populeti* on *Populus alba*, 12.07.1998, Leg. O. Petrović; 13♂, 22♀, Niš: Popovac, 25.05.2010, Leg. V. Žikić; 3♂, 1♀, Belgrade-Galovica, ex *Chaitophorus* spp. on *Populus alba*, 14.05.2000, Leg. Ž. Tomanović; 50♂, 83♀, Niš: Popovac, 18.06.2010; 25♂, 14♀, 14.05.2010; 08♂, 10♀, 22.05.2010; 3♂, 6♀, 25.06.2010; 2♂, 3♀, Vlasina Lake, 18.06.2010, Leg. V. Žikić; 1♂, Niš, ex *Chaitophorus tremulae* on *P. tremula*, 25.05.2010, Leg. M. Ilić; 10♂,

Table 1. List of hosts from the orders Coleoptera, Diptera, Hemiptera and Hymenoptera in trophic associations with *Populus* species.

Order	Family	Species	<i>P. alba</i>	<i>P. balsamifera</i>	<i>P. deltoides</i>	<i>P. x. euramer.</i>	<i>P. nigra</i>	<i>P. x. berolinensis</i>	<i>P. tremula</i>	<i>Populus</i> spp.	
Coleoptera	Rhynchitidae	<i>Byctiscus populi</i> (Linnaeus 1758)	X	-	-	-	-	-	X	X	
	Bostrichidae	<i>Xyloniates praeustus</i> Germar 1817	-	-	-	-	-	-	-	X	
	Buprestidae	<i>Agrilus cyanescens</i> Ratzeburg 1837	-	-	-	-	-	-	-	-	X
		<i>Chrysobothris affinis</i> (Fabricius 1794)	X	-	-	-	-	-	-	-	X
		<i>Melanophila pictadecastigma</i> (Fabricius 1787)	X	-	-	-	X	-	-	X	-
		<i>Poecilota variolosa</i> (Paykull 1799)	X	-	-	-	X	-	-	X	-
	Cerambycidae	<i>Aegomorphus clavipes</i> (Schrank 1781)	-	-	-	-	-	-	-	-	X
		<i>Apriona germari</i> (Hope 1831)	-	-	-	-	-	-	-	-	X
		<i>Rhagium mordax</i> (De Geer 1775)	X	-	-	-	X	-	-	X	-
		<i>Saperda populnea</i> (Linnaeus 1758)	-	-	-	X	X	-	-	-	X
		<i>Saperda punctata</i> (Linnaeus 1767)	-	-	-	-	X	-	-	-	-
	Curculionidae	<i>Hylesinus crenatus</i> (Fabricius 1787)	-	-	X	-	X	-	-	-	X
		<i>Taphrorhynchus</i> sp.	-	-	-	-	-	-	-	-	X
Diptera	Agromyzidae	<i>Agromyza albitarsis</i> Meigen 1830	X	X	X	-	-	-	-	-	
		<i>Aulagromyza tremulae</i> (Hering 1957)	-	-	X	X	-	-	-	-	
		<i>Paraphytomyza populi</i> (Kaltenbach 1864)	X	-	X	X	-	-	-	-	
Hemiptera	Aphididae	<i>Chaitophorus leucomelas</i> Koch 1854	X	-	-	-	X	-	-	X	
		<i>Chaitophorus populeti</i> (Panzer 1801)	X	-	X	-	X	X	X	-	
		<i>Chaitophorus populialbae</i> (Boyer de Fonscolombe 1841)	-	-	-	-	X	-	X	X	
		<i>Chaitophorus</i> sp.	X	-	-	-	X	-	X	-	
		<i>Pterocomma populeum</i> (Kaltenbach 1843)	X	-	-	-	X	-	X	X	
		<i>Pterocomma</i> sp.	X	-	X	-	X	-	X	-	
Hymenoptera	Tenthredinidae	<i>Fenusella hortulana</i> (Klug 1818)	-	-	-	-	X	-	-	X	
		<i>Nematus bipartitus</i> Serville 1823	-	-	-	-	-	-	-	X	
	Xiphydriidae	<i>Xiphydria camelus</i> (Linnaeus 1758)	-	-	-	-	-	-	-	X	
		<i>Xiphydria prolongata</i> (Geoffroy 1785)	-	-	-	-	-	-	-	-	X

39♀, Mt Beljanica, on *P. tremula*, 29.07.1996, Leg. O. Petrović; 2♂, 3♀, Užice: Trešnjica, 23.07.1996, Leg. Ž. Tomanović; 14♂, 13♀, Niš: Popovac, 22.05.2010, Leg. V. Žikić; 10♂, 1♀, New Belgrade: blok 62, ex *Chaitophorus leucomelas* on *Populus nigra*, 17.05.2006, Leg. Ž. Tomanović; 08♂, 10♀, Lebane: Konjino, on *Populus nigra*, 06.06.2010, Leg. S. Stanković; 11♂, 13♀, Mt Divčibare, 05.08.2000, Leg. O. Petrović; 10♀, Ečka, on *Populus nigra*, 6♂, 24.05.2002, Leg. Ž. Tomanović; 6♂, 10♀, Mt Beljanica, on *Populus* sp. 29.07.1996, Leg. O. Petrović; 6♂, 10♀, Novi Sad, 01.06.1996, Leg. L. Pajnik; 45♀, New Belgrade, 06.06.1999, Leg. Ž. Tomanović. Hosts: *Chaitophorus leucomelas* on *P. alba*, *Chaitophorus populeti* on *P. alba*, *P. nigra* and *P. tremula*; *Chaitophorus populialbae* on *P. nigra* and *P. tremula* (Kavallieratos et al. 2004), *Chaitophorus* sp. on *P. alba*, *P. nigra* and *P. tremula*. (Kavallieratos et al. 2004, Tomanović et al. 2006). Distribution: Andorra, Bulgaria, Croatia, Czech Republic, France, Germany, Greece, Hungary, Moldova, Poland,

Russia (northwest), Slovakia, Spain, The Netherlands, Nearctic region.

Areopraon chaitophori Tomanović & Petrović 2009* Serbia: 14♂, 3♀, Zemun, ex *Chaitophorus leucomelas* on *Populus nigra*, 09.09.2007, Leg. A. Petrović. Hosts: *Chaitophorus leucomelas* on *Populus nigra* (Tomanović et al. 2009a). Distribution: Serbia.

Ephedrus chaitophori Gardenfors 1986* Serbia: 1♂, 1♀, New Belgrade, ex *Chaitophorus* sp. on *Populus nigra*, 06.06.1999, Leg. Ž. Tomanović. Hosts: *Chaitophorus leucomelas* on *Populus nigra* (Kavallieratos et al. 2004), *Chaitophorus* sp. on *P. alba* (Tomanović et al. 2006). Distribution: Finland, France, Germany, The Netherlands, Oriental region.

Euaphidius cingulatus Ruthe 1859* Serbia: 9♂, 12♀, Belgrade: Radmilovac, ex *Pterocomma populeum* on *Populus* sp. 09.05.1998, Leg. Ž. Tomanović; 7♂, 7♀, Novi Sad, ex *Pterocomma* sp. on *Populus deltoides*, 20.08.2000, Leg. L. Pajnik. Hosts: *Pterocomma popu-*

Table 2. List of hosts from the order Lepidoptera in trophic associations with *Populus* species.

Family	Species	<i>P. alba</i>	<i>P. x euramer.</i>	<i>P. nigra</i>	<i>P. tremula</i>	<i>P. tremulooides</i>	<i>P. grandidentata</i>	<i>P. simonii</i>	<i>P. robusta</i>	<i>Populus</i> spp.
Erebidae	<i>Arctia caja</i> (Linnaeus 1758)	-	-	-	X	-	-	-	-	-
	<i>Gynaephora selenitica</i> (Esper 1789)	-	-	-	X	-	-	-	-	-
Geometridae	<i>Hypagyrtis unipunctata</i> (Haworth 1809)	-	-	-	-	-	-	-	-	X
Gracillariidae	<i>Phyllonorycter blancardella</i> (Fabricius 1781)	X	-	X	-	-	-	-	-	-
	<i>Phyllonorycter comparella</i> (Duponchel 1843)	X	-	-	-	-	-	-	-	-
	<i>Phyllonorycter crataegella</i> (Clemens 1859)	X	-	X	-	-	-	-	-	-
Gelechiidae	<i>Anacamptis populella</i> (Clerck 1759)	-	-	-	-	-	-	-	-	X
Lasiocampidae	<i>Malacosoma neustria</i> (Linnaeus 1758)	-	-	-	-	-	-	-	-	X
Noctuidae	<i>Acronicta psi</i> (Linnaeus 1758)	-	-	-	-	-	-	-	-	X
	<i>Acronicta rumicis</i> (Linnaeus 1758)	-	-	-	-	-	-	-	-	X
	<i>Amphipyra pyramidea</i> (Linnaeus 1758)	-	-	X	-	-	-	-	-	-
	<i>Catocala nupta</i> (Linnaeus 1767)	-	-	X	-	-	-	-	-	-
	<i>Hyphantria cunea</i> (Drury 1773)	-	-	-	-	X	-	-	-	-
	<i>Leucoma salicis</i> (Linnaeus 1758)	-	-	-	-	X	X	X	-	X
	<i>Nycteola revayana</i> (Scopoli 1772)	-	-	-	X	-	-	-	-	-
	<i>Orgyia antiqua</i> (Linnaeus 1758)	-	-	-	-	X	-	-	-	-
	<i>Orthosia gothica</i> (Linnaeus 1758)	-	-	-	X	-	-	-	-	X
	<i>Orthosia populeti</i> (Fabricius 1781)	-	-	-	-	-	-	-	X	-
	<i>Orthosia</i> sp.	X	-	-	-	-	-	-	-	-
Notodontidae	<i>Cerura menciana</i> Moore 1877	-	-	-	-	-	-	-	-	X
	<i>Cerura vinula</i> (Linnaeus 1758)	-	-	-	-	-	-	-	-	X
	<i>Clostera pigra</i> (Hufnagel 1766)	-	-	-	X	-	-	-	-	X
	<i>Eligmodonta ziczac</i> Linnaeus 1758	-	-	X	-	-	-	-	-	-
	<i>Furcula bifida</i> (Brahm 1787)	-	-	-	-	-	-	-	-	X
	<i>Furcula palaestinensis</i> Bartel-Gaede 1933	-	-	-	-	-	-	-	-	X
Sesiidae	<i>Paranthrene tabaniformis</i> (Rottentburg 1775)	X	X	X	X	-	-	-	-	X
	<i>Sesia apiformis</i> (Clerck 1759)	-	-	-	-	-	-	-	-	X
	<i>Adoxophyes orana</i> (Fischer v. Roslerstamm 1834)	X	-	X	X	-	-	-	-	X
	<i>Archips rosana</i> (Linnaeus 1758)	-	-	-	-	-	-	-	X	X
	<i>Gypsonoma aceriana</i> (Duponchel 1842)	X	X	-	X	-	-	-	-	X
	<i>Pandemis heparana</i> (Denis & Schiffermuller 1775)	X	X	X	-	-	-	-	-	-
	<i>Tortrix viridana</i> Linnaeus 1758	X	-	-	-	-	-	-	-	X

leum on *P. alba*, *P. nigra* and *P. tremula*; *Pterocomma* sp. on *P. tremula* (Kavallieratos et al. 2004). Distribution: Britain, Czech Republic, France, Germany, Hungary, Iceland, Italy, Lithuania, Moldova, Montenegro, Poland, Russia (central, north, northwest, south), Slovakia, Spain, The Netherlands.

Subfamily Braconinae

Atanycolus denigrator (Linnaeus 1758) Hosts: *Poecilota variolosa* and *Rhagium mordax*, on *P. alba*, *P. nigra* and *P. tremula* (Tobias et al. 1986, Papp 1998), *Saperda populnea* on *Populus x euramericana* and *P. nigra* (Tobias 1976, Tobias et al. 1986). Distribution: Austria, Bulgaria, Croatia, Finland, France, Germany, Greece, Hungary, Italy, Norway, Poland, Russia (central, northwest,

south), Serbia, Sicily, Slovakia, Spain, Sweden, Switzerland, Ukraine.

Atanycolus sculpturatus (Thomson 1892)* Serbia: 1♀, Draževac: Obrenovac, Malaise Trap. 11-18.08.1995. Leg. Lj. Mihajlović. Hosts: *Melanophila pictadecastigma* on *P. alba*, *P. nigra* and *P. tremula* (Kenis & Hilszczanski 2004). Distribution: Austria, Croatia, Czech Republic, Finland, France, Germany, Greece, Hungary, Italy, Romania, Russia (central, south), Slovakia, Spain, Sweden, Switzerland.

Bracon abbreviator Nees 1834* Serbia: 1♀, Belgrade, 01.06.1975. Leg. M. Brajković. Hosts: *Pandemis heparana* on *P. alba*, *Populus x euramericana* and *P. nigra* (Morley & Rait-Smith 1933). Distribu-

tion: Austria, Balearic Islands, Crete, Croatia, Cyprus, Czech Republic, Finland, Germany, Great Britain, Hungary, Poland, Romania, Slovakia, Spain, Sweden, Switzerland, The Netherlands, Afrotropical region.

Bracon discoideus Wesmael 1838 Hosts: *Byctiscus populi* on *P. tremula* (Evans, 2001), ex *Adoxophyes orana* on *P. nigra* (Denlinger et al. 1973, Özbek et al. 2009), ex *Saperda populnea*, on *Populus* spp. (Yu et al. 2005). Distribution: Austria, Belgium, Bulgaria, Czech Republic, France, Germany, Great Britain, Hungary, Ireland, Italy, Poland, Romania, Russia (northwest), Serbia, Slovakia, Slovenia, Sweden, Switzerland, The Netherlands, Afrotropical region.

Bracon fulvipes Nees 1834 Hosts: *Paranthrene tabaniformis* on *P. alba*, *P. nigra*, *P. tremula*, *Populus* spp. (Ceianu & Radoi 1971). Distribution: Austria, Belgium, Bulgaria, Croatia, Great Britain, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Poland, Russia (central, south), Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, The Netherlands, Turkey (European part).

Bracon hebetor Say 1836* Serbia: 50♂, 11♀, Niš, 27.08 - 04.09.2008, Leg. V. Žikić. Hosts: *Adoxophyes orana* on *P. alba*, *P. nigra*, *P. tremula*, *Populus* spp. (Yu et al. 2005). Distribution: Austria, Azores, Belgium, Great Britain, Bulgaria, Canary Islands, Crete, Croatia, Cyprus, Czech Republic, Dodecanese Islands, Finland, France, Germany, Greece, Hungary, Italy, Lithuania, Former Yugoslav Republic of Macedonia, Madeira, Northern Ireland, Poland, Russia (central, south), Sicily, Slovakia, Slovenia, Spain, The Netherlands, Turkey (European part), Afrotropical region, Australian region, Nearctic region, Neotropical region, Oriental region.

Bracon intercessor Nees 1834* Serbia: 1♂, Pančevački Rit, ex *Saperda populnea* on *P. nigra*, 24.04.1954; 2♂, Jabučki Rit, ex *Paranthrene tabaniformis* on *P. alba*, *P. tremula*, 17.04.1955. Leg. D. T; 1♂, Padinska Skela, ex *Paranthrene tabaniformis* on *P. alba*, *P. tremula*, 23.04.1995. Leg. D. T; 1♂, Zaječar, 07.08.1980; 1♂, Kopaonik, 11.06.1989. Leg. M. Brajković. Hosts: *Paranthrene tabaniformis* on *Populus* spp. (Georgiev 2000a), *Saperda populnea* on *Populus* spp. (Yu et al. 2005). Distribution: Albania, Austria, Bulgaria, Canary Islands, Crete, Croatia, Cyprus, France, Germany, Great Britain, Greece, Hungary, Italy, Latvia, Lithuania, Former Yugoslav Republic of Macedonia, Norway, Poland,

Romania, Russia (central, east, northwest, south), Slovakia, Slovenia, Spain, Sweden, Switzerland, The Netherlands, Turkey (European part), Ukraine, Afrotropical region.

Bracon picticornis Wesmael 1838 Hosts: *Nematus bipartitus* (Author) on *Populus* sp. (Beyarslan et al. 2005). Distribution: Austria, Belgium, Great Britain, Bulgaria, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Poland, Russia (central, northwest, south), Serbia, Slovakia, Spain, Sweden, Switzerland, The Netherlands, Turkey (European part).

Bracon romani Fahringer 1927 ex *Paranthrene tabaniformis*, *Sesia apiformis* on *Populus* spp. (Georgiev 2001b). Distribution: Greece, Hungary, Serbia, Slovakia, Slovenia, Sweden, The Netherlands.

Bracon variator Nees 1811* Serbia: 1♀, Merošina: Dudulajce, *Gypsonoma aceriana* on *P. tremula*, 18.07.1978; 1♂, 1♀, Stara Mt., 12.07.1979; 1♀, Sokolovica, 10.08.1985; 1♂, Sićevo Gorge, 06.08.1995; 1♀, Kovilovo, 17.05.1992; 1♀, Niš: D. Matejevac, ex *Gypsonoma aceriana* on *P. alba*, 18.07.1978; 2♀, Jastrebac, 13.07.1978; 1♀, Ristovac, 17.06.1982; 1♀, Košutnjak, 18.07.1987; 1♀, Povlen, 30.07.1982; 1♀, Tara Mt. 11.08.1982; Leg. M. Brajković. Hosts: *Gypsonoma aceriana* on *Populus x euramericana* (Georgiev & Samuelian 1999). Distribution: Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Canary Islands, Crete, Croatia, Cyprus, Czech Republic, Dodecanese Islands, Finland, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Former Yugoslav Republic of Macedonia, Moldova, Poland, Romania, Russia (central, east, north, northwest, south), Sicily, Slovakia, Slovenia, Spain, Sweden, Switzerland, The Netherlands, Turkey (European part), Ukraine.

Bracon variegator Spinola 1808* Montenegro: 1♀, Tivat, 16.07.1980; 1♀, 18.07.1980; Leg. M. Brajković. Hosts: *Archips rosana*, *Tortrix viridana* on *Populus* spp. (Beyarslan et al. 2005). Distribution: Austria, Belgium, Bulgaria, Canary Islands, Crete, Cyprus, Czech Republic, Finland, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Former Yugoslav Republic of Macedonia, Poland, Romania, Russia (central, northwest, south), Slovakia, Slovenia, Spain, Turkey (European part), Australian region.

Coeloides filiformis Ratzeburg 1852 Hosts: *Hylesinus crenatus* on *P. deltoides* (Kenis et al. 2004). Distribution: Austria, Belgium, Czech Republic, Finland,

France, Germany, Great Britain, Hungary, Italy, Lithuania, Norway, Poland, Romania, Russia (central), Serbia, Slovakia, Spain, Sweden, Switzerland, The Netherlands, Ukraine, Afrotropical region.

Iphiaulax impostor (Scopoli 1763) Hosts: *Aegomorphus clavipes*, *Apriona germari*, *Saperda populnea* on *Populus* spp. (Tobias et al. 1986). Distribution: Albania, Austria, Belarus, Bulgaria, Crete, Croatia, Cyprus, Czech Republic, Dodecanese Islands, Greece, Hungary, Italy, Latvia, Lithuania, Former Yugoslav Republic of Macedonia, Moldova, Norway, Poland, Romania, Russia (central, east, north, northwest, south), Serbia, Sicily, Slovakia, Spain, Sweden, Switzerland, Ukraine, Afrotropical region.

Vipio tentator (Rossi 1790) Hosts: *Agrilus cyaneus* on *Populus* spp. (Yu et al. 2005) Distribution: Corsica, Crete, Croatia, Czech Republic, Germany, Hungary, Italy, Former Yugoslav Republic of Macedonia, Romania, Russia (central, south), Serbia, Sardinia, Sicily, Slovakia, Spain, Turkey (European part), Afrotropical region.

Subfamily Charmontinae

Charmon extensor (Linnaeus 1758) Hosts: *Saperda populnea* on *Populus x euramericana*, *P. tremula* (Georgiev et al. 2004a). Distribution: Austria, Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Hungary, Ireland, Italy, Lithuania, Norway, Poland, Russia (central, northwest, south), Sardinia, Slovakia, Serbia, Sweden, Switzerland, The Netherlands, Afrotropical region, Nearctic region.

Subfamily Doryctinae

Dendrosoter protuberans (Nees 1834) Hosts: *Hylesinus crenatus* on *Populus* spp. (Bright & Skidmore 2002, Kenis et al. 2004). Distribution: Belgium, Croatia, Czech Republic, Finland, France, Germany, Great Britain, Hungary, Italy, Latvia, Lithuania, Norway, Poland, Romania, Russia (central, northwest, south), Serbia, Slovakia, Spain, Sweden, Switzerland, The Netherlands, Nearctic region.

Doryctes leucogaster (Nees 1834)* Serbia: 2♀, Niš: Popovac, 10.05.2002; 1♀, ex *Chrysobothris affinis* on *Populus alba*, 20.05.2002; 1♀, 10.06.2002; 1♂, 1♀, 30.05.2002; 1♂, 1♀, 30.04.2002; 3♂, 25.04.2002. Leg. V. Žikić; 1♂, Leskovac: Vučje, (Malaise Trap) 06.05.1997. Leg. Lj. Stanisavljević; Montenegro: 2♀,

Mt. Durmitor: Sušica, 06.08.2005, Leg. V. Žikić. Hosts: *Chrysobothris affinis* on *Populus* spp. (Yu et al. 2005). Distribution: Austria, Belgium, Bulgaria, Corsica, Croatia, Czech Republic, France, Germany, Greece, Great Britain, Hungary, Italy, Latvia, Lithuania, Former Yugoslav Republic of Macedonia, Norway, Poland, Romania, Russia (central, northwest, south), Sardinia, Slovakia, Spain, Sweden, Switzerland, The Netherlands, Afrotropical region.

Doryctodes longicaudis (Giraud 1857) Hosts: *Saperda punctata* on *P. nigra* (Parey 1944). Distribution: Austria, Croatia, France, Germany, Hungary, Italy, Romania, Russia (northwest), Serbia.

Spathius rubidus (Rossi 1794) Hosts: *Xylonites praeustus*, on *Populus* sp. (Bonnemaison 1962, Derwesh 1963), ex *Taphrorychus* sp., *Xiphydria prolongata* (Yu et al. 2005). Distribution: Austria, Belgium, Bulgaria, Canary Islands, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy, Kaliningrad Region, Lithuania, Moldova, Norway, Poland, Russia (central, northwest, south), Serbia, Sicily, Slovakia, Spain, Sweden, Switzerland, The Netherlands, Ukraine, Afrotropical region.

Spathius umbratus (Fabricius 1798) Hosts: *Saperda populnea* on *Populus* sp. (Kenis & Hilszczanski 2004). Distribution: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Great Britain, Hungary, Italy, Latvia, Madeira, Norway, Poland, Romania, Russia (central, northwest, south), Sardinia, Serbia, Sicily, Slovakia, Spain, Sweden, Switzerland, The Netherlands, Ukraine, Afrotropical region.

Rhopetrocentrus piceus Marshall 1897* Serbia: 1♀, Stara Pazova, ex *Xiphydria prolongata* on *P. tremula*, 10.06.1997. Leg. Ž. Tomanović; 1♀, Obrenovac: Draževac (Malaise Trap), 30.07 - 06.08.1994. Leg. Lj. Mihajlović. Hosts: *Xiphydria camelus* on *Populus* sp. (Smith 2001). Distribution: Austria, Bulgaria, Croatia, France, Germany, Greece, Hungary, Italy, Moldova, Poland, Romania, Russia (central, east, south), Slovakia, Spain, Sweden, Ukraine, Nearctic region.

Subfamily Exothecinae

Colastes braconius Haliday 1833 Hosts: *Agromyza albitarsis*, *Tortrix viridana* on *P. alba* (Yu et al. 2005). Distribution: Austria, Belgium, Bulgaria, Czech

Republic, Denmark, Finland, France, Germany, Great Britain, Hungary, Ireland, Italy, Kaliningrad Region, Lithuania, Norway, Poland, Russia (central, east, northwest, south), Serbia, Slovakia, Sweden, Switzerland, The Netherlands, Ukraine.

Shawiana catenator (Haliday 1836) Hosts: *Fenusella hortulana* on *P. nigra* (Yu et al. 2005, Georgiev 2006). Distribution: Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Great Britain, Hungary, Ireland, Italy, Latvia, Lithuania, Poland, Russia (Northwest), Serbia, Spain, Sweden, The Netherlands, Ukraine, Afrotropical region.

Subfamily Macrocentrinae

Macrocentrus marginator (Nees 1811) Hosts: *Gypsonoma aceriana* on *Populus x euramericana* (Georgiev & Samuelian 1999) ex *Paranthrene tabaniformis* on *Populus x euramericana*, *P. tremula* (Georgiev 2000b), ex *Leucoma salicis* (Yu et al. 2005) on *P. tremuloides* (Prebble 1943). Distribution: Austria, Belarus, Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Great Britain, Hungary, Ireland, Italy, Latvia, Lithuania, Moldova, Norway, Poland, Romania, Russia (central, northwest, south), Serbia, Slovakia, Sweden, Switzerland, The Netherlands, Ukraine, Nearctic region.

Subfamily Microgastrinae

Apanteles arisba Nixon 1973 Hosts: *Phyllonorycter comparella* on *P. alba* (Yu et al. 2005). Distribution: Denmark, Germany, Great Britain, Hungary, Greece, Norway, Serbia, Slovakia, Spain.

Apanteles bicolor (Nees 1834) Hosts: *Phyllonorycter blancardella*, *Ph. crataegella* on *P. alba*, *P. nigra* (Yu et al. 2005). Distribution: Austria, Belgium, Bulgaria, Canary Islands, Croatia, Czech Republic, Finland, France, Germany, Great Britain, Hungary, Ireland, Italy, Lithuania, Moldova, Norway, Poland, Romania, Russia (Chita, Kamchatka, Moscow, Yaroslavl), Serbia, Slovakia, Spain, Switzerland, The Netherlands, Ukraine, Canada-Ontario, China (Jiangsu, Ningxia), Georgia, Japan, Korea, Mongolia, Turkmenistan, New Zealand.

Apanteles congestus (Nees 1834) Hosts: *Catocala nupta* on *P. nigra* (Yu et al. 2005). Distribution: Belgium, Bulgaria, Croatia, Czech Republic, Estonia, Finland, France, Germany, Great Britain, Hun-

gary, Italy, Lithuania, Poland, Romania, Russia (all regions), Serbia, Slovakia, Spain, Sweden, Switzerland, Ukraine, Georgia, China, Iran, Israel, Japan, Kyrgyzstan, Mongolia, Turkey, Turkmenistan, Uzbekistan.

Apanteles erevanicus Tobias 1976 Hosts: *Gypsonoma aceriana* on *Populus x euramericana*, *Populus* spp. (Georgiev & Samuelian 1999). Distribution: Bulgaria, Serbia.

Apanteles evonymellae (Bouché 1834) Hosts: *Paranthrene tabaniformis* on *Populus* sp. (Georgiev 2001b). Distribution: Belarus, Bulgaria, Czech Republic, Germany, Great Britain, Hungary, Italy, Portugal, Russia (central, south), Serbia, The Netherlands, Armenia, Azerbaijan, Lebanon.

Apanteles melanoscelus Ratzeburg 1844 Hosts: *Anacamptis populella*, on *Populus* sp. (Stanionyte & Dzhankmen 1990), *Leucoma salicis* on *P. grandidentata* (Wagner & Leonard 1980), on *Populus* sp. (Georgiev & Beshkov 2000); on *P. simonii* (Györfi 1943); on *P. tremuloides* (Prebble 1943). Distribution: Austria, Belarus, Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Great Britain, Hungary, Italy, Latvia, Lithuania, Moldova, Poland, Portugal, Romania, Russia (Krasnodar Kray, Kirov, Chita, Altayskiy, Yaroslavl), Serbia, Slovakia, Spain, Sweden, Switzerland, The Netherlands, Ukraine, Kazakhstan, Tajikistan, Turkey, U.S.A. (all regions), Canada (all regions), China (all regions), India, Iran, Japan, Korea, Mongolia.

Cotesia rubripes (Haliday 1834) Hosts: *Eligmodonta ziczac* on *P. nigra* (Györfi 1959). Distribution: Belarus, Bulgaria, Croatia, Czech Republic, France, Germany, Hungary, Israel, Italy, Lithuania, Poland, Romania, Russia (Krasnodar Kray, Krasnoyarsk Kray, Moscow Oblast, Tomsk, Voronezhskaya Oblast, Yaroslavl Oblast), Serbia, Switzerland, Ukraine, Uzbekistan, Kazakhstan, Korea, Mongolia, Morocco.

Microgaster solitaria (Ratzeburg 1844) Hosts: *Leucoma salicis* on *P. tremuloides* (Prebble 1943). Distribution: Belgium, Bulgaria, Finland, France, Germany, Greater Britain, Hungary, Italy, Lithuania, Moldova, Poland, Romania, Russia (Krasnodar Kray, Yaroslavl), Serbia, Slovakia, Spain, Sweden, Switzerland, The Netherlands, Ukraine, Kazakhstan, Tajikistan, Turkey, U.S.A. [= *Cotesia melanoscela* (Ratzeburg 1844)].

Microplitis ratzeburgii (Ruthe 1858)* Serbia: 1♂,

Niš: Prosek, 15.08.1997, Leg. V. Žikić. Hosts: *Furcula palaestinensis* on *Populus* sp. (Halperin 1986). Distribution: Bulgaria, Denmark, Finland, France, Germany, Italy, Japan, Poland, Russia (Chita Oblast), Armenia, Israel, Serbia.

Microplitis xanthopus (Ruthe 1860) Hosts: *Orthosia populeti* on *P. robusta* (Györfi 1959). Belarus, Bulgaria, Croatia, Finland, Georgia, Germany, Great Britain, Hungary, Ireland, Italy Italy, Moldova, Poland, Romania, Russia, Russia-Irkutsk, Krasnodar Kray, St. Petersburg, Volgograd, Yaroslavl Oblast), Serbia, Sweden, Switzerland, Ukraine, Kazakhstan.

Subfamily Opiinae

Opius propodealis Fischer 1958 Hosts: *Agromyza albitarsis* on *P. nigra* (Fischer 1972, 1997). Distribution: Austria, Czechoslovakia, Estonia, Finland, France, Germany, Great Britain, Hungary, Italy, Lithuania, Poland, Russia (Krasnodar, Chita Primorye, Sakhalin), Serbia, Spain, Switzerland, The Netherlands, Korea.

Utetes rotundiventris (Thomson 1895) Hosts: *Agromyza albitarsis* on *P. balsamifera* (Fischer 1972). Distribution: Austria, Czechoslovakia, Estonia, France, Germany, Great Britain, Hungary, Italy, Lithuania, Poland, Russia (Krasnodar, Chita Primorye, Sakhalin), Serbia, Spain, Switzerland, The Netherlands, Korea.

Subfamily Orgilinae

Orgilus obscurator (Nees 1812) Hosts: *Gypsonoma aceriana* on *Populus x euramericana*, *P. alba*, *P. tremula*, *Populus* spp. (Georgiev & Samuelian 1999, 2000). Distribution: Czech Republic, Germany, Hungary, Serbia, Slovakia, The Netherlands.

Subfamily Rogadinae

Aleiodes compressor (Herrich-Schaffer 1838) Hosts: *Nycteola revayana* on *P. tremula* (Papp 1985), *Clostera pigra* on *P. tremula*, *Populus* spp. (Rougeot & Viette 1978, Yu et al. 2005). Distribution: Austria, Belgium, Bulgaria, Czech Republic, Estonia, Finland, France, Germany, Great Britain, Hungary, Italy, Montenegro, Norway, Poland, Russia (central, northwest), Serbia, Slovakia, Spain, Sweden, Switzerland, The Netherlands, Ukraine, Nearctic region.

Aleiodes gastritor (Thunberg 1822)* Serbia: 1♀, Niš: Popovac, 13.10.2002, Leg. V. Žikić; 1♀, Mt.

Kopaonik, Bare (1700-1800 m a.s.l.), 13.07.1988; 4♂, Mt. Kopaonik, Suvi Jelak (1550-1650 m a.s.l.), 20.06.1986, Leg. A. Četković; Montenegro: 1♂, Mt. Durmitor, Komarnica, 15.08.1986, 1♂, Mt. Durmitor, Sušica lake (1100-1200 m a.s.l.) (light trap), 13.08.1986, Leg. A. Četković; 2♂, Mt. Durmitor, Žabljak (1850-1920 m a.s.l.), 07.06.1985, Leg. D. Pavićević. Hosts: *Hypagyrtis unipunctata* on *Populus* spp. (Summerville et al. 1999, Barbosa & Caldas 2004). Distribution: Bulgaria, Canary Islands, Crete, Finland, Germany, Great Britain, Greece, Italy, Madeira, Norway, Poland, Russia (central, northwest, south), Slovakia, Spain, Sweden, Switzerland, The Netherlands, Turkey (European part).

Aleiodes nigricornis Wesmael 1838* Serbia: 1♀, Niš, Sicevo Gorge, ex *Orthosia* sp. on *P. alba*, 23.07.1998, Leg. V. Žikić; 2♂, Prokuplje, Mala Dragaša, 22.08.1987, Leg. A. Četković. Hosts: *Orthosia gothica* on *Populus* spp. (Mold et al. 1998, Schwarz & Shaw 2000). Distribution: Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Poland, Russia (northwest), Slovakia, Spain, Sweden, Switzerland, The Netherlands.

Aleiodes pallescens Hellen 1927 Hosts: *Cerura menciana*, *C. vinula*, *Furcula bifida* ex *Populus* spp. (Yu et al. 2005, Kryukov 2006). Distribution: Belgium, Finland, Montenegro.

Aleiodes pallidator (Thunberg 1822) Hosts: *Leucoma salicis* on *Populus* spp. (Yu et al. 2005, Shaw 2006). Distribution: Austria, Belgium, Bulgaria, Crete, Croatia, Czech Republic, Finland, France, Germany, Great Britain, Greece, Hungary, Italy, Lithuania, Norway, Poland, Russia (northwest), Serbia, Slovakia, Sweden, Switzerland, The Netherlands, Turkey (European part), Nearctic region.

Aleiodes rossicus (Kokujev 1898) Hosts: *Malacosoma neustria*, *Leucoma salicis*, *Cerura vinula*, *Archips rosana* on *Populus* spp. (Aydogdu & Beyarslan 2006). Distribution: Belarus, Bulgaria, Croatia, Finland, Germany, Hungary, Italy, Moldova, Russia (central), Serbia, Slovakia, Spain, Ukraine. [= *A. gastritor* Thunberg 1822].

Aleiodes sanctihyacinthi (Provancher 1880) Hosts: *Hyphantria cunea* (Sourakov & Paris 2009) on *P. tremuloides* (Karban & Ricklefs 1984). Distribution: Nearctic region, introduced to Serbia.

Aleiodes signatus (Nees 1811) Hosts: *Orygia anti-*

qua on *P. tremuloides* (Prebble 1943), *Acronicta psi*, *A. rumicis* on *Populus* spp. (Skinner 1984), ex *Arctia caja* on *P. tremula*, (Seppänen 1970), ex *Gynaephora selenitica* on *P. tremula* (Robinson 2001, Yu et al. 2005). Distribution: Albania, Austria, Belgium, Bulgaria, Croatia, Czech Republic, Finland, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Poland, Romania, Russia (central, south), Serbia, Slovakia, Spain, Sweden, Switzerland, The Netherlands, Turkey (European part).

Aleiodes (Chelonorhogas) aterrimus (Ratzeburg 1852) Hosts: *Amphipyra pyramidea* on *P. nigra* (Allan 1949, Yu et al. 2005). Distribution: Austria, Belgium, Czech Republic, France, Germany, Great Britain, Hungary, Italy, Norway, Poland, Romania, Russia (northwest, south), Serbia, The Netherlands, Turkey (European part).

Discussion

This is a summary of the fauna of Braconidae found on poplars in Serbia and Montenegro associated with their hosts. The basic research on tri-trophic associations reveals information about the various host insect species that is often rather useful in later identification of the parasitoid wasp species. On the other hand, information on trophic associations is a key background in the detection of interactions between mutually dependent organisms in native ecosystems, such as meadows, forests and agroecosystems. Information about all these interactions makes it easy to conduct biodiversity studies and application in biological control projects (Trdan et al. 2006). The first example is *Leucoma salicis* (Noctuidae) (table 2), which was present on four poplar species. In southeastern Europe, the caterpillars of this moth species are controlled by four of above presented species: *Apanteles melanoscelus*, *Aleiodes pallidator*, *Aleiodes rosicus* and *Microgaster solitaria*, and *Meteorus versicolor* (Wesmael 1835) in the Nearctic (Wagner & Leonard 1980) and Palaearctic regions. One of the most destructive xylophagous insect attacking various species of *Populus* is *Paranthrene tabaniformis* (Sesiidae), known as poplar clearwing moth (Georgiev 2000b). Candidates suitable for biological control of *P. tabaniformis* are three parasitoids of the genus *Bracon* consisting of *B. fulvipes*, *B. intercessor* and *B. romani*, as well as the two other species, *Macrocentrus marginator* and *Apanteles evonymellae*.

On the investigated territory as well in whole of Europe, *Populus tremula* is the most suitable host plant for various poplar feeding pest insects. Two other autochthonous species, *Populus alba* and *P. nigra*, are also attacked by numerous pests. Our investigation, along with investigations of other authors, gives information that subfamilies Braconinae (14), Microgastrinae (10) and Rogadinae (9) are the most numerous parasitoid species attacking pests associated with poplars. In this study, *Bracon* was dominant in number of species (10) than *Aleiodes* with eight species.

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