

Acta entomologica serbica, 2016, 21: 113-122

UDC 595.79(497.11)  
595.79(497.16)  
DOI: 10.5281/zenodo.198454

## ENSIGN WASPS OF SERBIA AND MONTENEGRO (HYMENOPTERA: EVANIOIDEA: EVANIIDAE)

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### Abstract

This paper presents the first report on ensign wasp fauna in two central Balkan countries, Serbia and Montenegro. We established the presence of three species (out of five recorded in Europe): *Brachygaster minutus*, *Prosevania fuscipes* and *Zeuxevania splendidula*, the last based on an old literature report. We briefly discuss the patterns of their distribution and occurrence, in relation to their specific bionomy and the collecting techniques applied.

KEY WORDS: *Brachygaster*, *Prosevania*, *Zeuxevania*, parasitoids

### Introduction

Members of the family Evaniidae are parasitoid wasps that oviposit their eggs in the oothecae (egg-case) of cockroaches (e.g., Crosskey, 1951; Roth & Willis, 1960; Brown, 1973). Their larvae live solitarily inside an egg-case, feeding on its nutrition contents (Townes, 1949; Cameron, 1957; Deans, 2008). Together with Aulacidae and Gasteruptionidae, the family Evaniidae is classified in the superfamily Evanioidea (Deans, 2008). The three families share the common trait of a metasoma attached very high on the propodeum. In addition, members of the Evaniidae have a unique general morphology, with relatively large, nearly cubic mesosoma and comparably small, petiolate and laterally compressed metasoma. Although the higher phylogeny of the group, based primarily on these morphological peculiarities, has occasionally been questioned (e.g., Crosskey 1951; Carlson 1979), this arrangement was recently fully confirmed by molecular evidence (Heraty *et al.*, 2011; Sharkey *et al.*, 2012). Currently, about 21 extant genera of Evaniidae are known in world fauna,

and estimates of species number vary from around 430-440 (Deans, 2005, 2008; Ghahari & Deans, 2010) to 580 (Mullins *et al.*, 2012). There is evidence that Evaniidae may be potentially useful biological control agents of pestiferous cockroaches in stored-product facilities (Ceianu, 1986; Thoms & Robinson, 1987; Fox & Bressan-Nascimento, 2006), but this group of parasitoids has been largely neglected by both taxonomists and applied entomologists (Deans & Huben, 2003).

This predominantly tropical group is poorly represented in Europe, with only five species belonging to four genera: *Brachygaster minutus* (Olivier, 1792), *Evania appendigaster* (Linnaeus, 1758), *Prosevania fuscipes* (Illiger, 1807), *P. incerta* (Kieffer, 1904) and *Zeuxevania splendidula* (Costa, 1884) (Deans, 2005; Madl, 2013). It is possible that *P. incerta* is actually the junior synonym of *P. fuscipes*, though this is currently difficult to establish: *P. incerta* is known only from the type specimen(s) (from Greek island of Rhodes), whose depository is currently not known (Deans, 2005). On the other hand, several authors treated *Zeuxevania dinarica* (Schletterer) as different from *Z. splendidula* (e.g., Kieffer, 1912; Pagliano, 1986; Wall, 1994). Here we accept the taxonomy and nomenclatural arrangement from the most comprehensive world catalogue of the Evaniidae (Deans, 2005; Deans *et al.*, 2016).

The genus *Brachygaster* Leach is widely distributed, from tropical Africa, through the Mediterranean and most of Eurasia to Australia, where it was only recently discovered (Elliott, 2005). Of the nine species included, only *Brachygaster minutus* is present in Europe (Tschamtko, 1984; Madl, 2013). As summarized by Deans (2005), this smallest European evaniid is known to parasitize three species of *Ectobius* Stephens: *E. pallidus* (Olivier), *E. panzeri* (Stephens) and *E. lapponicus* (L.); there are also several records of association with *Blattella germanica* (L.) (Schletterer, 1889; Kieffer, 1912; Crosskey, 1951; Cameron, 1957), and even with *Blatta orientalis* L. (Cameron, 1957), all of which are best regarded as dubious (cf. Wall, 1994; Deans, 2005). Other evaniid species are larger and attack bigger cockroach taxa. Of special interest is the common household cockroach *Blatta orientalis*, a widespread synanthropic species of Oriental origin, which is attacked by the almost cosmopolitan parasitic wasp *Evania appendigaster* (Townes, 1949; Cameron, 1957; Stange, 2000; Deans, 2005), as well as by the widespread synanthropic species *Prosevania fuscipes* (Townes, 1949; Ceianu, 1986; Deans, 2005). Probably of Oriental origin, *Evania appendigaster* was most commonly recorded as a parasitoid of another important large household cockroach, *Periplaneta americana* (L.), also cosmopolitan but probably of African origin (Deans, 2005). Furthermore, it parasitizes two more large and widespread *Periplaneta* species: *P. australasiae* (F.) and *P. brunnea* Burmeister (also present in Europe as introduced; cf. Fauna Europaea data base), and several non-European cockroaches: *Melanozosteria soror* (Brunner von Wattenwyl) in Indomalaya and New Zealand, *Neostylopyga rhombifolia* (Stoll) in Australia, etc. (Perrott, 1966; Beccaloni, 2007). *Zeuxevania splendidula* is a moderately sized ensign wasp, probably native to the Mediterranean, and its only known host is the lobe-winged cockroach *Loboptera decipiens* (Germar); its life cycle is fully presented in Clausen (1940).

The relatively poor fauna and general paucity of most evaniid taxa in Europe probably hindered interest in more extensive research of the group. Until recently, the whole Evanioidea superfamily was insufficiently and sporadically investigated in most of the Balkans. For Gasteruptiidae, there is a comprehensive recent faunistic account of the territories of the former Yugoslavia (Žikić *et al.*, 2014), while extremely few data are available for Aulacidae and Evaniidae from this region (mostly from Croatia) (Maidl, 1923; Wall, 1994; Deans, 2005; Madl, 2013). Here we surveyed the ensign wasps of Serbia and Montenegro, about which almost no data were available (except for the single topographically misinterpreted record "from Croatia", originating from the historical province of Dalmatia: see in Nonveiller, 1999, and below).

## Materials and Methods

Here we present a study of ensign wasps collected sporadically in the period 1957-2015 in many localities throughout Serbia and Montenegro. Collecting was not specifically focused on this group, so many of the specimens are the "by-catch" of mass-collecting techniques targeted at some other Hymenoptera. Specimens of *Prosevania fuscipes* were sampled by hand or by hand-net, exclusively within buildings in urban environments; specimens of *Brachygaster minutus* were mostly collected by Malaise traps or sweep-netting, and in only a few cases by hand net. It is worth noting that trapping was performed throughout the vegetation season during several nonconsecutive years, but many samples were without any Evaniidae catch; if we count the duration of successful trapping episodes only, the mass-collected material is the result of 155 trap/days and 16 netting rounds.

All localities are mapped in Google Earth software, including the single record available from literature (Maidl, 1923), and the altitude range for each location was additionally checked with available topographic maps. The numbered list of all collecting sites with contemporary toponymy comprises 27 georeferenced points, accompanied by altitude (a [kml](#) file is available as an on-line supplement). Serbia: 1. Vršачki Breg (200-500 m; 45.135368072° N, 21.400269183° E); 2. Deliblato Sands, Rošijana (80-120 m; 44.917345683° N, 21.117250547° E); 3. Belgrade [centre1] (100-150 m; 44.818871765° N, 20.456761491° E); 4. Belgrade [centre2] (100-150 m; 44.807795548° N, 20.46688818° E); 5. Avala Mt (near Belgrade) (250-350 m; 44.698472736° N, 20.525138933° E); 6. Obrenovac, Draževac (80-180 m; 44.588714467° N, 20.24376728° E); 7. Požarevac, Crveni krst / Čačalica (100-200 m; 44.622514289° N, 21.204931332° E); 8. Stara Planina Mt, Topli Do (700 m; 43.339689648° N, 22.67692649° E); 9. Stara Planina Mt, Žarkova Čuka (1550-1650 m; 43.377915566° N, 22.626721525° E); 10. Niš, Popovac (180-200 m; 43.3275° N, 21.823055556° E); 11. Lebane, Konjino (260-280 m; 42.93° N, 21.76° E); 12. Radan Mt, Ivanje env. (850 m; 42.998060995° N, 21.550430713° E); 13. Blace, Mala Draguša (350-380 m; 43.2693533° N, 21.347833222° E); 14. Kopaonik Mt, Žljeb (1700-1770 m; 43.312201412° N, 20.837561482° E); 15. Kopaonik Mt, Pojla (1580-1630 m; 43.266158765° N, 20.793219715° E); 16. Kopaonik Mt, Treska (1540-1600 m; 43.263418212° N, 20.787547737° E); 17. Kopaonik Mt, Treska/Šiljak (1450-1550 m; 43.257911108° N, 20.78346703° E); 18. Kopaonik Mt, Kukavica (1650-1726 m; 43.329077993° N, 20.744646606° E); 19. Kopaonik Mt, Samokovska River Gorge (780-820 m; 43.357609746° N, 20.741222502° E); 20. Užice, Ponikovica (400-500 m; 43.874452304° N, 19.924858225° E); 21. Tara Mt, Kaludjerske bare (970-1100 m; 43.889204908° N, 19.539883457° E); Montenegro: 22. Tara River Canyon, Djurdjevića Tara (750-800 m; 43.14829° N, 19.291559° E); 23. Durmitor Mt, Pitomine (1420-1540 m; 43.15828378° N, 19.107003781° E); 24. Komarnica River Canyon, Nevidio (1000 m; 42.987522905° N, 19.06723624° E); 25. Herceg Novi, Savina (20-60 m; 42.452213982° N, 18.554510841° E); 26. Herceg Novi, Igalo (5-100 m; 42.459963341° N, 18.517551109° E); 27. Ulcinj (5-100 m; 41.92605418° N, 19.205095795° E).

Generally, European genera and species of Evaniidae are easy to recognize and differentiate on the basis of several characteristics of external morphology, which have been extensively treated by numerous authors (e.g. Schletterer, 1889; Kieffer, 1912; Hedquist, 1973; Pagliano, 1986; Madl, 1989; Deans & Huben, 2003, etc.). We based our identification on these descriptions and keys, taking into account incomplete coverage and the need for taxonomic and nomenclatural updating in many of them. A large share of the examined material is part of the personal collection of AČ, while several voucher specimens are deposited in the collection of the Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Serbia ["FSUN" in the list of material]. The initials of the authors (VŽ, AP, AČ) are given alongside the specimens they collected; other collectors are given their full surnames and initials. Mass-collecting

techniques are indicated by respective abbreviations ("MT" for Malaise trap, "SN" for sweep-netting), while the few specimens listed without these indications were individually captured.

## Results and Discussion

In total, we studied 134 Evaniidae specimens collected from 21 localities (within 14 wider areas) in Serbia and from five localities in Montenegro; there is also an additional locality from Montenegro based on the literature. The studied material comprised two species: *Brachygaster minutus* (Fig. 1) and *Prosevania fuscipes* (Fig. 2), both recorded from Serbia as well as Montenegro. The third species, *Zeuxevania splendidula*, was included only from the single literature record.

### *Brachygaster minutus* (Olivier, 1791)

Analysed material: Serbia – Vršачki breg (leg. AĆ), 13.06.1987: 1♀ 4♂ (SN); Deliblato Sands, Rošijana (leg. AĆ), 05.07.1987: 7 specimens (MT: 3 traps); Avala Mt (near Belgrade) (leg. AĆ), 08.07.1987: 1♀; Obrenovac, Draževac (leg. Mihajlović Lj.), 26.08.1990: 1♀ 1♂ (MT), 30.07. / 06.08.1994: 2♂ (MT), 01/05.08.1995: 8♂ (MT), 11/18.08.1996: 1♂ (MT); Požarevac, Crveni krst / Čačalica (leg. AĆ), 06.07.1987: 1♂ (SN); Stara Planina Mt, Topli Do (leg. AĆ), 28/29.07.1983: 1♀ (MT); Stara Planina Mt, Žarkova Čuka (leg. Mesaroš G.), 14.07.1983: 1♂ (SN); Niš, Popovac (leg. VŽ), 01/11.07.2012: 2♀ 3♂ (MT), 25.07. / 15.08.2012: 4♂ (MT) [FSUN]; Lebane, Konjino (leg. Stanković S.), 10/30.06.2013: 1♂ (MT) [FSUN]; Radan Mt, Ivanje env. (leg. Jakšić P.), 28.06. / 01.07.2000: 3♂ (MT); Blace, Mala Draguša (leg. AĆ), 04.07.1982: 1♂, 06.07.1983: 1♂ (SN), 27.08.1987: 1♂ (SN), 27/28.08.1987: 1♀ 2♂ (MT), 26/27.08.1989: 1♂ (MT), 27.08. / 07.09.1989: 1♂ (MT), 15/18.08.1990: 1♂ (MT); Kopaonik Mt, Žljeb (leg. AĆ), 14.07.1988: 17♂ (SN), 14/15.07.1988: 3♂ (MT); Kopaonik Mt, Pojla (leg. AĆ), 07.08.1986: 16♂ (SN), 12.07.1988: 4♂ (SN); Kopaonik Mt, Treska (leg. AĆ), 07.08.1986: 2♂ (SN); Kopaonik Mt, Treska/Šiljak (leg. AĆ), 22.06.1986: 1♂ (SN); Kopaonik Mt, Kukavica (leg. AĆ), 15/21.07.1988: 1♂ (MT); Kopaonik Mt, Samokovska River Gorge (leg. AĆ), 18.07.1987: 1♂ (SN), 17/18.07.1987: 4♂ (MT); Užice, Ponikovica (leg. Tomanović Ž.), 08/25.06.1997: 1♀ (MT), 12/31.07.1997: 1♂ (MT), 01/20.09.1997: 1♂ (MT), VI-VIII.1997: 6♂ (MT); Tara Mt, Kaludjerske bare (leg. AĆ), 09.08.2004: 2♂. Montenegro – Tara River Canyon, Djurdjevića Tara (leg. AĆ), 28.07.1990: 6♂ (MT); Durmitor Mt, Pitomine (leg. AĆ), 20.08.1986: 3♂ (SN); Komarnica River Canyon, Nevidio (leg. AĆ), 26.06.1988: 1♂ (SN).

The presented material is likely among the largest datasets on *B. minutus* in published faunistic accounts for comparable territories in Europe. Although trapping was the significantly more extensively applied technique, about 52% of specimens were collected from ca. 25 Malaise trap samples, while nearly 45% of specimens were from 14 sweep-netting samples (taken in only 13 days). This abundant material was collected over large spatial and temporal scales, covering most of their phenology in several nonconsecutive years. Hence, samples probably covered most of the seasonal activity of *B. minutus* (June-September), which is generally correlated with the phenology of its hosts (e.g., Holuša & Kočáre, 2000). It is noteworthy that the recorded sex ratio in such a large sample is quite unbalanced: 8♀, 106♂ and 7 specimens of undetermined sex (the latter sample is temporarily not available for study, so we gave only the original specimen count). Six out of 8 females were collected by Malaise trapping.

Being common and widespread in Europe, *B. minutus* is usually considered a lowland-to-mid-montane species, with records mostly up to 1,000 m a.s.l., and rarely reported from higher altitudes (there are a few records from 1,300-1,850 m in Tirol (Schedl, 2012). In Serbia and Montenegro, with sampling locations

spanning from the south-eastern Pannonian Plains through the central Balkan mountains, this species was recorded more evenly along a wide altitudinal range (roughly 80-1,750 m a.s.l.). The difference may be attributed to the more southern position of the central Balkans in comparison with other studied areas in Europe. The real altitudinal range of *B. minutus* probably extends even further into the alpine zone, since areas above 1,800 m were largely undersampled by relevant methods. In the studied material, nearly 50 specimens (i.e. about 41% of the total catch) were from the higher montane zone (1,450-1,750 m) from 9 sampling events spanning over 14 effective days of trapping and/or netting. A similar number of specimens (55) from the lowland-to-hilly zone (80-500 m) was derived from much more intensive collecting (26 samples, involving more than 140 days of successful trapping and/or netting). The share of material from the middle zone (700-1,100 m) from 7 samples collected during 19 effective days is modest (18 specimens). Obviously, the different efficiency of the two techniques and uneven effort in their application along the elevation gradient influenced this somewhat biased pattern of regional and, in particular, altitudinal frequency distribution of *B. minutus* occurrence within the studied area.

In this respect, it is noteworthy that most of the collected females (7/8) are from the lower zone and none from the highest; consequently, the share of females is about 13% in the total lowland sampling, compared to less than 8% in the complete material. Obviously, the sex ratio is strongly unbalanced, and this unusual situation was also observed in some faunistic reports (Pagliano, 1986; Kofler & Madl, 1990), while the opposite ratio was recorded in others (Hedquist, 1973; Schedl, 2012). As shown, the sex ratio may have been partly biased by the collecting techniques, but this cannot fully explain such unbalanced ratios and/or activity pattern of the two sexes.

General distribution: throughout Europe (including Scandinavia and the British Isles) and circum-Mediterranean; earlier records from tropical Africa are now regarded as erroneous (Deans, 2005). With respect to other Balkan countries, in the Fauna Europaea database (Madl, 2013) it is checked only for Bulgaria, although *B. minutus* was previously listed also from Greece and Croatia (Maidl, 1923; Wall, 1994; Deans, 2005).

#### *Prosevania fuscipes* (Illiger, 1807)

Analysed material: Serbia – Belgrade [centre1] (leg. AĆ), 16.07.2009: 1♀, Belgrade [centre1] (leg. AP), 08.07.2014: 1♀, 13.05.2015: 1♂, 12.06.2015: 2♀, 07.09.2015: 1♀ [FSUN]; Belgrade [centre2] (leg. Pavićević D.), 17.07.2012: 1♀, 23.10.2012: 2♀ (found dead). Montenegro – Herceg Novi, Igalo (leg. Pavićević D.), 19.06.1997: 2♀ 1♂; Ulcinj (leg. Grozdanović J.), 24.08.1957: 1♂.

General distribution of *P. fuscipes* is almost worldwide (all continents except Australia), but outside of Africa the species is found only in urban environments, and is hence, probably native to southern Africa (cf. Deans, 2005). So far it was recorded in several countries in central and southern Europe, including five Balkan countries: Bosnia-Herzegovina, Bulgaria, Croatia, Greece, and Turkey (European part) (Fahringer, 1922; Deans, 2005; Madl, 2013). It seems to have been continuously present in the Mediterranean zone of the Balkans (several specimens from the Croatian coast from the first half of XX century were observed), but its presence in the more continental City of Belgrade is probably a result of very recent successful introduction, possibly assisted by climate change. Its principal host in Europe is likely *Blatta orientalis*, a much more widespread synanthropic cockroach than *Periplaneta americana*. Hence, its occasional occurrence throughout temperate-zone locations of Europe is much more frequent than another large evaniid of tropical origin, *E. appendigaster*. However, it is questionable how permanent their presence may be towards more northern areas. As a synanthropic species, *B. orientalis* reproduces continuously in buildings, hence its

parasitoids may produce up to three generations per year (Ceianu, 1986). So far, we have recorded *P. fuscipes* only from May through October.



Figure 1. *Brachygaster minutus* male: a) body – lateral view, b) head – frontal view, c) head and mesosoma – dorsal view.

#### *Zeuxevania splendidula* (Costa, 1884)

As noted above, there is a single published record of this species from Montenegro, under the name *Z. dinarica* (Schletterer, 1886), listed as being from "Dalmatien: Savina" (Maidl, 1923). In fact, the area name refers to the historical province of Dalmatia, which was entirely within Austro-Hungaria at the time of collection; most of Dalmatia is now in Croatia, but Savina is in its easternmost part, now in Montenegro (within outskirts of modern municipality of Herceg-Novi).

Species is generally not very common, but it was recorded from many south-European countries (Spain, France, Italy incl. Sardinia, Croatia, Greece, Bulgaria) and also from Egypt (Wall, 1994; Deans, 2005; Madl, 2013); apparently, the Savina record was included under Croatia.



Figure 2. *Prosevania fuscipes* female: a) body – lateral view, b) head – frontal view, c) head and mesosoma – dorsal view.

### Acknowledgement

We would like to thank to all colleagues who kindly provided the material for this study: Lj. Mihajlović, P. Jakšić, D. Pavićević, Ž. Tomanović (all from Belgrade), G. Mesaroš (Subotica), S. Stanković (Niš). English language proofreading was done by Dr. Lydia Mitits and Antonis Mylonopoulos (Komotini, Greece). We are also grateful to Dr. Andrew R. Deans for all his comments and advices. The research was supported by the Grant III43001 of the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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## ЕВАНИИДЕ СРБИЈЕ И ЦРНЕ ГОРЕ (HYMENOPTERA: EVANIOIDEA: EVANIIDAE)

ВЛАДИМИР ЖИКИЋ, АНЂЕЉКО ПЕТРОВИЋ И АЛЕКСАНДАР ЋЕТКОВИЋ

### Извод

Ова студија представља први извештај о фауни еваниида на територији две централно-балканске државе, Србији и Црној Гори. Установили смо да су присутне три од укупно пет врста регистрованих у Европи: *Brachygaster minutus*, *Prosevania fuscipes* и *Zeuxevania splendidula*, од којих је последња презентована само на бази старог литературног податка. Укратко смо продискутовали обрасце њиховог присуства и дистрибуције у односу на специфичну биологију ове групе, као и технике примењене у прикупљању материјала.

Received: May 26th, 2016  
Accepted: November 25th, 2016