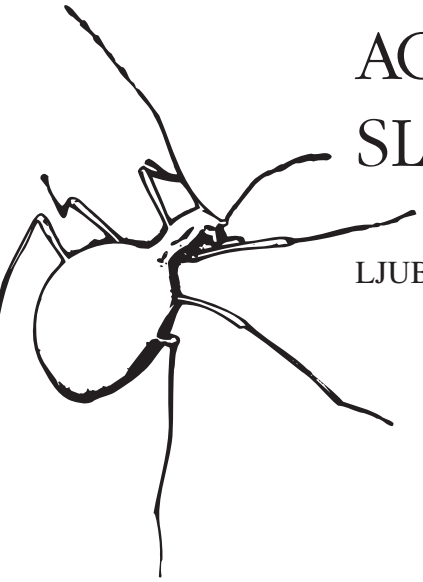

ACTA ENTOMOLOGICA SLOVENICA

LJUBLJANA, JUNIJ 2017 Vol. 25, št./No. 1

PRIRODOSLOVNI MUZEJ SLOVENIJE
SLOVENSKO ENTOMOLOŠKO DRUŠTVO
ŠTEFANA MICHIELIJA

ACTA ENTOMOLOGICA SLOVENICA

Revija Slovenskega entomološkega društva Štefana Michielija
in Prirodoslovnega muzeja Slovenije
Izhaja dvakrat letno / Issued twice a year

ISSN 1318-1998
CODEN: AESLFM
UDC (UDK) 595.7(051)

Izdajatelja / Publishers

Slovensko entomološko društvo
Štefana Michielija
ZRC SAZU, Novi trg 5
SI-1000 Ljubljana

Prirodoslovni muzej Slovenije
Prešernova 20, p.p. 290
SI-1001 Ljubljana

letnik/Vol. 25, št./No. 1, 2017
Tisk / Printed by: Trajanus, d.o.o., Kranj
Ljubljana, junij 2017

http://www.pms-lj.si/si/o-nas/arhiv-publikacij/acta-entomologica-slovenica

Povzeto v / To be abstracted in: The Zoological Record, CAB Abstracts

Revijo dobivajo člani Slovenskega entomološkega društva Štefana Michielija
(članarina 20 EUR)
Cena posamezne številke je 8,50 EUR
Zamenjava je zaželjena / Exchanges appreciated
Publikacija je natisnjena s pomočjo Javne agencije za raziskovalno dejavnost R Slovenije.
Uredniško delo podpira Ministrstvo za kulturo R Slovenije.

Vsebina / Contents

FAVNISTIČNI ZAPISKI / FAUNISTICAL NOTES

Navodila avtorjem

Acta entomologica slovenica je glasilo Slovenskega entomološkega društva Štefana Michielija in Prirodoslovnega muzeja Slovenije. Objavlja izvirna znanstvena dela, pregledne članke in ocene knjig s področja entomologije. Članki lahko obravnavajo favnistiko, sistematiko, ekologijo, etologijo, fiziologijo ali zoogeografijo žuželk. Pisani naj bodo v slovenskem ali angleškem jeziku, z obveznim angleškim in slovenskim izvlečkom. Članki so strokovno recenzirani. Letno izideta dve številki.

Avtorje prosimo, da se pri oblikovanju člankov zgledujejo po zadnji številki revije. Če je le mogoče, svoj tekst pošljite po elektronski pošti ali oddajte na digitalnem nosilcu. Izpis članka na papirju naj ima dvojne presledke med vrsticami, da je možno popravljanje. Risbe naj bodo kontrastne, pri debelini črt pa upoštevajte tudi morebitno pomanjšanje na format revije. Slike naj bodo v izvirnih datotekah, če jih oddajate v elektronski obliki.

Citirana literatura naj se navede na koncu članka in naj bo razvrščena po abecedi glede na priimke avtorjev.

Avtorji člankov dobijo brezplačno 20 posebnih odtisov in članek v elektronski obliki.

Instructions to authors

Acta entomologica slovenica is the Journal of the Slovenian Entomological Society Štefan Michieli and the Slovene Museum of Natural History. It publishes original scientific works, overview articles, and book reviews in the field of Entomology. Articles may deal with faunistics, systematics, ecology, etology, physiology, or zoogeography of insects. They may be written in Slovene or English, with abstracts in English and Slovene (the editors will ensure translations into Slovene). All articles are reviewed. Two issues are published a year.

We ask all authors to model the layout of their manuscripts on a previous issue of the Journal. If possible, send the text by e-mail or on a digital carrier, as well as on paper with double spacing between lines. Drawings must have high contrast. Please, consider that all line widths may be reduced during layout of the issue. Pictures should be in their original files if prepared in digital form.

References should be listed at the end of the article in the alphabetical order of the authors' names.

20 reprints and electronic version will be sent to the Authors free of charge.

ACTA ENTOMOLOGICA SLOVENICA

LJUBLJANA, JUNIJ 2017 Vol. 25, št. 1: 5–64

REVISION AND RESURRECTION OF THE GENUS NAME *MEZAMMIRA* FIEBER, 1876 (HEMIPTERA: CICADIDAE) WITH SPECIAL FOCUS ON ITS SPECIES FROM GREECE AND THE DESCRIPTION OF TWO NEW SPECIES

Matija GOGALA[1], Stéphane PUISSANT[2,3], Tomi TRILAR[4]

[1)] Slovenian Academy of Science and Arts, Novi trg 2, Ljubljana, Slovenia,
e-mail: matija.gogala@guest.arnes.si
[2)] Muséum – Jardin des Sciences, Mairie de Dijon, Dijon, France
[3)] Institut de Systématique, Évolution, Biodiversité,
Muséum national d'Histoire naturelle, Sorbonne Universités, Paris, France
e-mail: spuissant@ville-dijon.fr
[4)] Slovenian Museum of Natural History, Prešernova 20, Ljubljana, Slovenia,
e-mail: ttrilar@pms-lj.si

Abstract - Cicada species of the genus *Mezammira* Fieber, 1876, previously known as species of the genus *Cicadivetta* Boulard, 1982, *Cicadetta* Kolenati, 1857, *Melampsalta* Kolenati, 1857, *Tettigetta* Kolenati, 1857 or also *Pauropsalta* Goding & Froggatt, 1904, were investigated in Greece. Arguments for a resurrection of the older generic name *Mezammira* are provided. Since the type species of this genus, *Mezammira flaveola* comb. nova, is lost or destroyed, we selected and are describing in this paper a neotype from the locality on Mt. Taigetos, not far from the *locus typicus* Mistra, Sparta, Greece, mentioned by Brullé (1833). We are adding also a description of a female, never published yet in the literature. Till now in Greece the following species of this genus were known: *Mezammira flaveola* comb. nova*, M. tibialis* comb. nova, *M. carayoni* comb. nova and *M. goumenissa* comb. nova. In the present paper we are describing in addition two new species: one from Peloponnese, *M. sakisi* sp. nova and one from Naxos Island, *M. filoti* sp. nova. Some of the Greek *Mezammira* species have very limited distribution areas. Their calling song patterns are characteristic with high repetition of short echemes of at least two different durations. Two of the species, *M. carayoni* comb. nova and *M. filoti* sp. nova are, according to our present knowledge, endemic to the islands of Crete and Naxos respectively and are allopatric to other *Mezammira* species. *Mezammira goumenissa* comb. nova and *M. sakisi* sp. nova live in sympatry or at least parapatry with the widely distributed *M.*

flaveola comb. nova in Southern Greece. This is probably the reason, that only these two species (*M. goumenissa* comb. nova and *M. sakisi* sp. nova) emit songs with the carrier frequency much higher than the remaining species, probably preventing acoustic interference.

KEY WORDS: *Mezammira*, *Cicadivetta,* taxonomy, bioacoustics, morphology, distribution, description, *Mezammira flaveola* comb. nova, neotype, *Mezammira sakisi* sp. nova, *Mezammira filoti* sp. nova, Greece

Izvleček - REVIZIJA IN PONOVNA UVEDBA RODOVNEGA IMENA *MEZAMMIRA* FIEBER, 1876 (HEMIPTERA: CICADIDAE) S POSEBNIM OZIROM NA VRSTE TEGA RODU V GRČIJI IN OPISOM DVEH NOVIH VRST

V Grčiji smo raziskovali škržade rodu *Mezammira* Fieber, 1876 (Hemiptera: Cicadidae), ki smo jih prej prištevali v rodove *Cicadivetta* Boulard, 1982, *Cicadetta* Kolenati, 1857, *Melampsalta* Kolenati, 1857, *Tettigetta* Kolenati, 1857 ali tudi *Pauropsalta* Goding & Froggatt, 1904. V članku navajamo utemeljitev za ponovno uvedbo rodovnega imena *Mezammira.* Ker je tipski primerek rodu, *Mezammira flaveola* comb. nova, izgubljen ali uničen, smo izbrali in v članku opisujemo neotip z lokalitete na Mt. Taigetosu, nedaleč od Mistre pri Šparti, Grčija, ki je *locus typicus*, kakor navaja Brullé (1833). Dodajamo še opis samice, ki do sedaj še ni bil objavljen. Do sedaj smo poznali v Grčiji naslednje vrste iz tega rodu: *Mezammira tibialis* comb. nova*, M. flaveola* comb. nova*, M. carayoni* comb. nova in *M. goumenissa* comb. nova. V tem članku objavljamo opisa dveh novih vrst s Peloponeza in z otoka Naxos, *M. sakisi* sp. nova in *M. filoti* sp. nova. Nekatere grške vrste iz rodu *Mezammira* imajo zelo ozko omejena območja razširjenosti. Skupna značilnost škržadov tega rodu so pozivni napevi s hitrim sosledjem kratkih ehemov vsaj dveh različnih dolžin. Dve vrsti, *M. carayoni* sp. nova in *M. filoti* sp. nova sta, kolikor vemo, endemični za otoka Kreto in Naksos ter sta alopatrični z ostalimi vrstami iz rodu *Mezammira*. *Mezammira goumenissa* comb. nova in *M. sakisi* sp. nova sta simpatrični ali vsaj parapatrični z vrsto *M. flaveola* comb. nova*,* ki je splošno razširjena v južni Grčiji. To je verjetno razlog, da imajo le napevi teh dveh vrst (*M. goumenissa* comb. nova in *M. sakisi* sp. nova) mnogo višje nosilne frekvence kot ostale vrste, kar verjetno zmanjšuje možnost križanja.

KLJUČNE BESEDE: *Mezammira*, *Cicadivetta,* bioakustika, morfologija, razširjenost, opisi, *Mezammira flaveola* comb. nova, neotip, *Mezammira sakisi* sp. nova, *Mezammira filoti* sp. nova, Grčija

Introduction

We begin with providing the arguments for the resurrection of the genus name *Mezammira* Fieber, 1876, instead of *Cicadivetta* Boulard, 1982a*, Cicadetta* Kolenati, 1857, *Melampsalta* Kolenati, 1857, or *Tettigetta* Kolenati, 1857 or also *Pauropsalta* Goding & Froggatt, 1904, and the species belonging to this genus are listed. In

Greece the genus *Mezammira* is represented by one of the widely distributed species in Europe, *Mezammira tibialis* (Panzer, 1798) comb. nova, which we found just recently in one locality near Litochoro (Gogala & Trilar, unpublished data). *Mezammira flaveola* (Brullé, 1833) comb. nova inhabits Peloponnese and some localities in continental Greece North of the Corinthian Gulf (Gogala & Drosopoulos, 2006). *Mezammira goumenissa* Gogala, Drosopoulos & Trilar, 2012 comb. nova was described recently under the name *Cicadivetta goumenissa* from a restricted area in Northern Peloponnese (Gogala et al., 2012, 2013) and *M. carayoni* (Boulard, 1982) comb. nova is an endemic species of the island of Crete (Boulard, 1982b; Trilar & Gogala, 2010).

During our investigations in recent years we discovered two new species belonging to the same genus *Mezammira*, one on the island of Naxos and the other in the Eastern Peloponnese: *M. filoti* sp. nova and *M. sakisi* sp. nova respectively, which we describe in this paper. We are also comparing characteristics of all other *Mezammira* species, found till now in Greece.

Materials and Methods

We collected data, recordings, specimens and observations during our expeditions to Greece in the cicada season in the years from 2004 to 2016 except the year 2009 (Fig. 1). Additional distributional data for this paper were provided by the second author (SP), W. Schedl and S. Drosopoulos† from their collections (Fig. 29, Table 1). We first localized cicadas acoustically and then, if possible, collected them with an entomological net. Collected and dry prepared specimens including the type material are deposited in the collection of the Slovenian Museum of Natural History (PMSL), additional material in the collections of the second author (SP) and S. Drosopoulos (his collection is currently deposited at the Agricultural University of Athens). Song recordings are deposited in the Slovenian Wildlife Sound Archive of the Slovenian Museum of Natural History (PMSL). Samples of selected recordings are available on the web pages Songs of European singing cicadas (http://www.cicadasong.eu).

In this paper we cite many times the work of Brullé (1833). There was a controversy about the year of publication, which is given on the front page of the book as 1832. We decided to follow the opinion of Gnezdilov and Bourgoin (2017) to change the publication year to 1833.

Taxonomy and morphology

The taxonomy and morphological terminology are based on Moulds (2005, 2012) and Sanborn (2014). *Mezammira* Fieber, 1876 belongs to the Cicadidae Latreille, 1802, subfamily Cicadettinae Buckton, 1889, and tribe Cicadettini Buckton, 1889. Morphometric measurements (using microscale of a microscope LEICA M205C) for formal descriptions are as follows (with accuracy indicated in parentheses):

BL: body length (0.1 mm);

FL: forewing length (0.1 mm);

FW: forewing width (0.05 mm);
VW: vertex width (0.024 mm);
HL: head length (0.016 mm);
HW: head width including eyes (0.05 mm);
PW: pronotum width including lateral angle of pronotal collar (0.05 mm);
Results are given as mean ± standard deviation (or minimum–maximum if N<6) if not stated otherwise.

For the names and spelling of localities we follow the local inscriptions and transliterations used in the maps of the "Nakas Road Cartography", Rafina Nr. 5, Nr. 8 and Skai Maps 311 Naxos. Distribution maps were created with GPS Visualizer (Schneider, 2003–2016).

Due to the high frequency range of the calls (see Gogala et al., 2012; Gogala & Drosopoulos, 2006), we detected the acoustic signals of these cicada species with the help of ultrasonic detectors. We used the ultrasonic detector Pettersson D-200 (heterodyne system) with electret microphones of the same producer (frequency range 10–120 kHz ± 0.15 kHz), mounted in front of a Telinga reflector (57 cm diameter) or a Renault R-4 front light reflector (15 cm diameter) and connected to the solid state recorders Marantz PMD-660, 670 (sampling rate up to 48 kHz) or Zoom H2 (sampling rate up to 96 kHz) (Gogala, 2013). For sound analyses, especially for determination of carrier frequency (center frequency, 5% and 95% frequency), we used RAVEN 1.4 (Cornell Lab of Ornithology), and for sonography we used AMADEUS Pro 2.0 (HairerSoft, 1998-2011) and the Seewave package (Sueur et al., 2008: oscillo, spectrogram, timer) on the R platform (R Core Team, 2015). For most of the macro photographs we used a Leitz multifocal system.

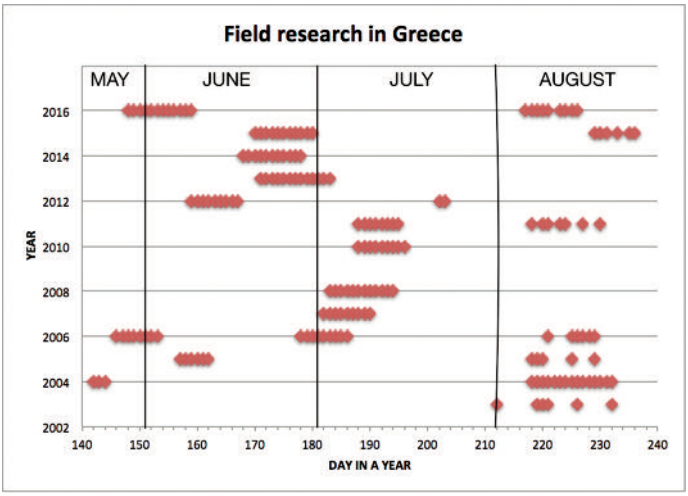

Fig. 1: Periods of our field research in Greece during years 2003 - 2016 within the main season for cicadas (May to August).

Fig. 2: Localities investigated during our field excursions to Greece 2004-2016.

Results

Taxonomy of the genus *Mezammira* Fieber, 1876

***Mezammira* Fieber 1876: 111**
(Figs. 4, 11, 12, 19, 26)
= *Heptaglena* Horváth (1911: 607) ***nomen praeoccupatum***: Horváth (1912), Dlabola (1959).
Type species: *Heptaglena libanotica* Horváth (1911: 607).
= *Oligoglena* Horváth (1912: 606) **syn. nov.**
Type species: *Oligoglena libanotica* Horváth (1911): Horváth (1912: 606).
= *Cicadivetta* Boulard (1982a: 50) **syn. nov.**
Type species: *Cicadivetta tibialis* (Panzer, 1798): Boulard (1982a: 50).
[*non Mezammira* Amyot, 1847: 157. *Nomen nudum*, unavailable name following ICNZ (Opinion 2165, 2006); *nec Mezammira* Amyot, 1848: 353. *Nomen nudum*, unavailable name following ICNZ (Opinion 2165, 2006)].

The valid genus name is the oldest potentially valid name (Article 23.1: ICZN, 1999) and the respective type species remains unchanged (Article 67.10). As these generic names with different name-bearing types refer to a single taxon, their names are subjective synonyms (Article 61.3.1.).

TYPE SPECIES. *Tibicen flaveolus* Brullé, 1833 by monotypy, see below.

Amyot (1847: 157; 1848: 353) fails to name a type species or representative. Fieber (1876: 50) considers taxa names of Amyot (1847) at the genus rank level. He quotes indeed "9. Genre *Cicadetta*. Am. mon. n° 377" and quotes also in his work on page 111 "*Mezammira* Am. mon. n° 379". As *Mezammira* Amyot (1847) is a *nomen nudum*, an unavailable name following ICNZ (Opinion 2165, 2006), Fieber (1876) is the first author to use the genus name *Mezammira* in a way that satisfies the criteria of availability. Fieber (1876) published the genus *Mezammira* as a junior synonym of *Cicadetta* and at the time the genus *Mezammira* was considered an available name. Indeed, it is only in 2006 that works of Amyot (1845–1847) were suppressed by the ICZN. Under the provisions of the Articles 11.6.1 and 50.7, the taxon dates from its first publication as a synonym. Fieber (1876) is therefore the author of *Mezammira,* who first published it as a junior synonym of the genus *Cicadetta* under the species *C. flaveola* (Brullé, 1833). Since Amyot failed to name a species in his genus *Mezammira,* Fieber (1876) is the first author to include a type species: *Tibicen flaveolus* Brullé (1833). The type species of this nominal genus, first published as a synonym is that nominal species first associated with it (Article 67.12): *Tibicen flaveolus* is automatically its type species by monotypy (Articles 67.2.2 and 69.3).

If the objects of the *Code* are to promote stability (Article 23.2), the reversal of precedence (Article 23.9) cannot be applied in this case under the common usage clause (Article 23.9.1.1) because the senior synonym has been used as a valid name after 1899 by Neave (1940: 143). Indeed, this author uses in his publication "*Mezammira* Amyot 1847, Ann. Soc. ent. France, (2) 5, 157.–Hem.". Therefore the prevailing usage of the name *Cicadivetta* cannot be maintained over *Mezammira* which has priority. Moreover, the work of Fieber (1876) fulfils the requirements of publication (Article 8), of availability (Article 11), of availability of a new name published before 1931 as there is a definition and an associated taxon (Article 12.1), of availability of the genus-group name because an available species name is used in association with *Mezammira* (article 12.2.5), and of the application of the genus-group name as there is a reference to a type species of the nominal taxon that it denotes (article 42.3). Even if there was a petition to suppress *Mezammira*, the genus *Oligoglena* Horváth (1912: 606) would then take precedence. So regardless, *Cicadivetta* is a junior synonym of the taxon.

However, it is also important to note that the description of Fieber (1876) doesn't match with the species *C. flaveola*: in his diagnosis Fieber probably describes a species belonging to the genus *Euryphara* Horváth, 1912. As Hagen (1856) and Puton (1875), Fieber (1872, 1876) considers *E. undulata* (Waltl, 1837) as a synonym of *M. flaveola* comb. nova and retains logically the older available name: *C. flaveola* (Brullé, 1833). Thus, if the type species is validly fixed, *M. flaveola* is not correctly described and misidentified with another species of small cicada. Therefore, the provision of article 70.3 applies (article 67.9) and in order to maintain the stability and universality of the nomenclature, we select under Article 70.3.1, and thereby fix as the type species, the nominal species previously cited as type species: *Tibicen flaveolus* Brullé, 1833.

We would also like to point out that Fieber (1876) mentioned *primo loco* Brullé's *Tibicen flaveolus* from Greece and that he had some doubts about identity of the taxon *C. virens* (= *Euryphara virens* (Herrich-Schäffer, 1835)) expressed by a question mark in front of it! During our field excursions we well investigated the region on and around Mt. Taigetos and all the small cicadas with yellow - black coloration near the locus classicus of Brullé (Mistra, Sparta, Greece) did correspond to a description of "*Tibicen flaveolus*" by the same author (Brullé, 1833).

DIAGNOSIS. Small species (body length 11–16 mm); length of the fore wings greater than 2.2 times of its width, not rounded at the apex; subcostal cell not expanded at the apex; forewing veins M and CuA meeting basal cell with their stems completely fused; hindwing with 4 to 6 apical cells, usually 5; male tergites 2 and 3 slightly enlarged, abdomen gradually narrowed caudad; sternite VIII as long or slightly shorter than sternite VII; uncus small, not dominant, duck-bill shaped; claspers hooked anterolaterad; pygofer dorsal beak well developed with basal lobe in ventral view showing inner tooth present.

Distribution and characteristics of taxa previously known from Greece

***Mezammira flaveola* (Brullé, 1833) comb. nova**

Tibicen flaveolus Brullé (1833): 112. [Type not examined, not found in the Muséum national d'Histoire naturelle (MNHN, Paris, France) and Muséum Jardin des Sciences de Dijon (MJSD, Dijon, France) collections, probably lost or destroyed.] Type locality: Peloponnese, Laconia, Mistra - Greece.

Cicada flaveola (Brullé, 1833): Walker (1850).

Cicadetta flaveola (Brullé, 1833): (Fieber, 1872).

Melampsalta flaveola (Brullé, 1833): Distant (1906).

Tettigetta flaveola (Brullé, 1833): Schedl (2001).

Cicadivetta flaveola (Brullé, 1833): Puissant & Sueur (2010), Gogala, Drosopoulos & Trilar (2012).

[*Cicadetta virens*: Fieber (1872), Hagen (1856), Puton (1875), Oshanin (1906), Gomez-Menor Ortega (1957), Nast (1972); *non* Herrich-Schäffer (1835). Misidentification].

[*Cicadetta undulata*: Fieber (1872), Hagen (1856), Puton (1875), Oshanin (1906), Gomez-Menor Ortega (1957); *non* Waltl (1837). Misidentification].

MORPHOLOGY. Figs. 3-6, 26c, 31a.

The species, described already by Brullé (1833) and depicted in his book (Fig. 3), has many morphological traits making the determination rather easy. Since the type specimen is lost or destroyed (see above) we selected a typical specimen from our material in the collection proposed to be a neotype. The locality, where this specimen has been collected, is on the southern slope of Mt. Taigetos not far from the Mistra castle, Sparta, Greece, the locus typicus of Brullé specimen. We should point out that this species is very abundant in the localities of higher elevations throughout the

Peloponnese (see below, Fig. 29), from the North (e.g. Mt. Panachaiko), West (e.g. Mt. Minthi), East (e.g. Mt. Korakovouni, Mt. Killini) and South (e.g. Mt. Taigetos).

NEOTYPE DESCRIPTION:

The **white label**: GR: Mani Peninsula/Mt. Taigetos/1.7.2013, 1288 m/N36° 56.735', E22° 22.536'/T.Trilar, M.Gogala leg.

The **red label**: NEOTYPE ♂/*Mezammira flaveola* (Brullé, 1833)/Gogala, Puissant & Trilar det. 2017.

The neotype is deposited in the Slovenian Museum of Natural History (Ljubljana, Slovenia).

Measurements: BL = 15.3 mm, FL= 16.2 mm, FW = 6.47 mm, HL = 8.48 mm, HW = 5.08 mm, PW = 5.49 mm, VW = 2.69 mm.

The body size of this species, given by Brullé is 13 mm. Measurements of our material provide for males a body length of 14.0±0.75 mm (12.6-15.5 mm, 38 males) and for females 14.1±0.5 mm (13.5-14.9 mm, 5 females).

Morphology, dorsal side

The main body coloration is yellow (e.g. neotype, to yellow-green in fresh animals), with black patterns (Figs. 4-6).

Head black, anterior parts of the supra-antennal plates, patch on frontal edge of postclypeus and a short median line at the epicranial suture yellow.

Pronotum - Pronotal collar, its lateral part, anterior edge of pronotum and the medial longitudinal band yellow. Two lateral fields and a dot in the middle of pronotal collar black (Figs. 4-6, 26c). This black dot is not connected with the hind edge of the pronotum or with the lateral black fields. (Only in a few male specimens (3 out of 43) there is a faint connection between this central dot and lateral fields.)

Mesonotum is also black with the exception of the yellow lateral edges, cruciform elevation, wing groove and the connected lateral posterior part of mesonotum yellow (Fig. 5c). Also **metanotum** except a darker basal part yellow.

Abdomen - First two terga black, the posterior edge of t2 yellow. Timbal with timbal plate, 2 long and two short ribs (Fig. 5a). Terga t3 - t8 yellow with black lateral patches and black medial part with exception of the yellow to orange posterior edge (Figs. 4, 5e, 5g). The extent of the black medial fields on terga is diminishing toward the genital segment.

Genital segment - The pygofer yellow, darker at the base. Genital segment of males has all the traits described for the genus *Mezammira*: conical inner tooth is present on the basal lobe (Figs. 5b, 31a), dorsal beak sharp, claspers pointed anterolaterad, pseudoparameres flat, short and not pointed at the tip (Figs. 5b, 31a).

Wings - Transparent**,** with exception of the yellow to orange basal parts, veins on forewings yellow, black around the apical cells. The number of apical cells on fore- and hindwings 8/5. Veins M+CuA on forewings connected to the basal cell by a common root, 1.4 times longer than arculus. First ulnar cell 1.4 times longer than the first apical cell. Plaga and the posterior edge of anal field on hind wings yellow, vein 2A gray infuscate.

Fig. 3: "Tibicen flaveolus" from the plate XXXI of the work of Brullé (1933).

Ventral side:

Head - Postclypeus dark, yellow at the lateral edges. Rostrum brown, with yellow mentum, reaching the posterior end of middle coxae (Figs. 5d, 5f).

Thorax - Sternum yellow with black patches and spots. Opercula reniform, yellow, not touching each other in the middle. Meracanthus yellow, triangular, flat and pointed. Fore legs yellow with dark patches and fasciae on coxae, trochanter and femora. Femur with primary spine and three secondary spines. Fore tibiae yellow and brown, tarsi brown to black distally. Mid and hind legs yellow with double dark patches on all parts of legs. One long and one short dark line on each femur. Tibiae yellow with basal black dots. Tarsal segments on mid and hind legs yellow, distally darker.

Abdomen - Sternites 1 and 2 yellow, dark in the middle parts. Sternites stIII - stVIII yellow. Sternite stVIII shorter (0.86 times) than stVII.

The female morphology of *Mezammira flaveola* comb. nova has never been described, therefore we show it here on the basis of the specimens from the collection PMSL (Fig. 4b). All together we have in this collection 4 specimens and further 2 are in the private collection of the second author (SP).

Measurements - BL = 14.2 mm (13.5-14.9 mm, N = 6), FL = 14.7 mm, FW = 5.85 mm, HL = 7.88 mm, HW = 4.71 mm, PW = 5.16 mm, VW = 2.29 mm. The ratio between M+CuA root length and arculus length is in this specimen 1 (in other specimens >1). Ulnar cell 1 is 1.78 times longer than apical cell 1.

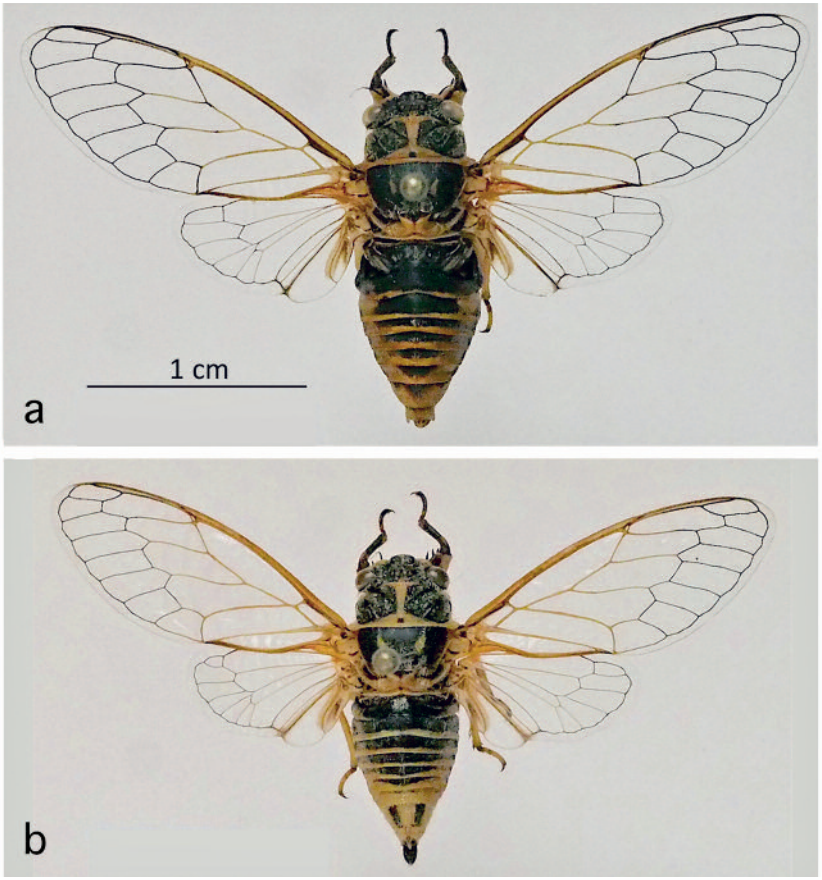

Fig. 4: *Mezammira flaveola* comb. nova; a - neotype male, b - female.

The main morphological characteristics are in female specimens very similar to those in males with exception of some thoracal (operculum) and abdominal structures. The most characteristic is abdominal segment 9, which is yellow with black longitudinal patches dorsally on both sides (Figs. 4b, 5g). In most animals also a dorsal beak is dark. Ovipositor brown, extending beyond the dorsal beak of abdominal segment 9 and anal styles (Fig. 5g).

DISTRIBUTION. *Mezammira flaveola* (Brullé, 1833) comb. nova under the name *Cicadivetta flaveola* (Brullé, 1833) in the work of Puissant & Sueur (2010) and Gogala, Drosopoulos & Trilar (2012), is not present in Spain. *Mezammira flaveola* comb. nova was indeed long confused with two other species inhabiting Spain which are *Euryphara virens* (Herrich-Schäffer, 1835) and *E. undulata* (Waltl, 1837), see: Fieber (1872: 2), Fieber (1876: 121), Hagen (1856: 89), Puton (1875: 111), Oshanin (1906: 19; 1912: 96) and Gomez-Menor Ortega (1957: 66). *Mezammira flaveola*

comb. nova is very different from *E. virens,* a species described by Amyot (1847, 1848) without being named in his work. *Euryphara virens* was also drawn by Gomez-Menor Ortega (1957: 67) under the name *Melampsalta flaveola* (misidentification).

This species is mentioned in the literature in many countries belonging to the Mediterranean or Asian area (see Metcalf, 1963; Duffels & Van der Laan, 1985 and Sanborn, 2014 for more precision). However, this small cicada is at present known with confidence only from Greece.

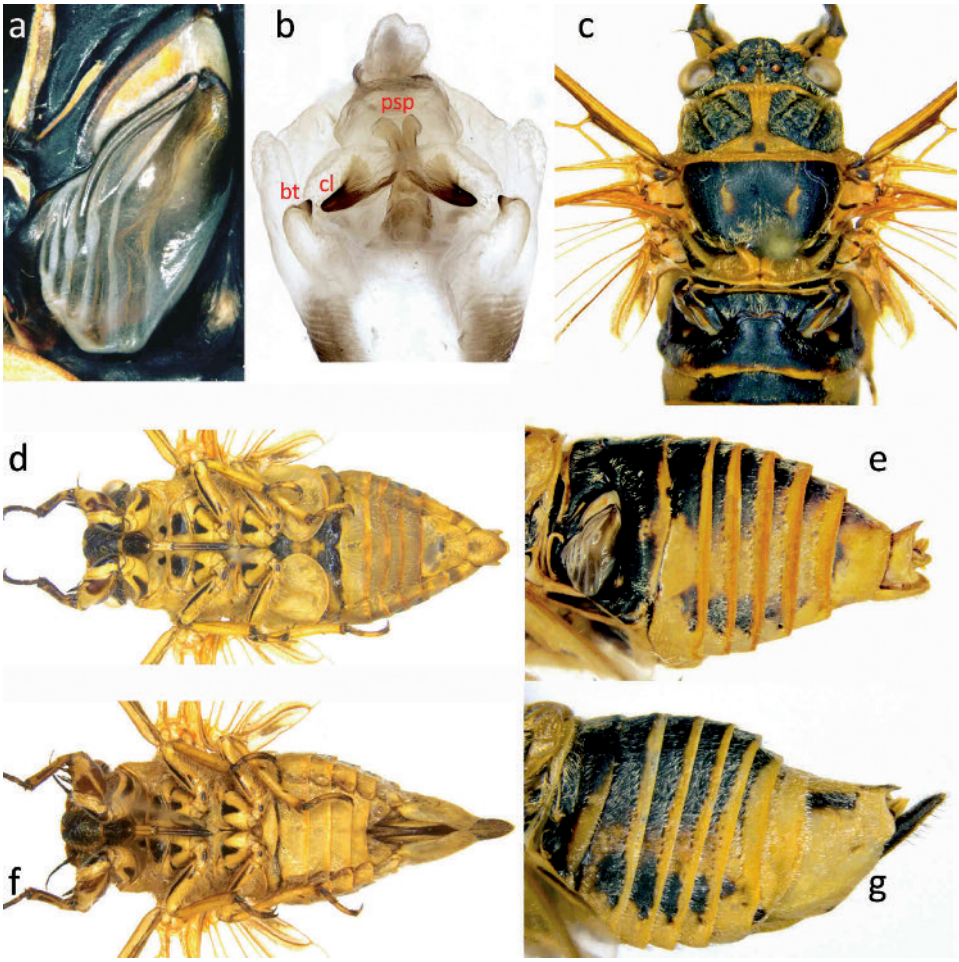

Fig. 5: *Mezammira flaveola* comb. nova, a, c-e - neotype male; f, g - female; a - left timbal; b - male genitalia (psp - pseudoparameres, cl - clasper, bt - tooth on the basal lobe of pygofer); c - details of central and anterior body parts; d - male body (neotype), ventral side; e - lateral view to the abdomen of the male neotype; f - ventral side of a female body with black markings on the legs, characteristic for animals of both sexes; g - lateral view to a female abdomen.

Fig. 6: *Mezammira flaveola* comb. nova from Mt. Mynthi, Peloponnese.

Fig. 7: Typical habitat of *Mezammira flaveola* comb. nova near the village Arbounas, Kleitoria, 1020m ASL.

This is the most common species of the genus *Mezammira* in Greece. We found it on Peloponnese and at some other localities in continental Greece north of the Corinthian Gulf. Outside of Peloponnese we found it on Mt. Elikona and in Epirus near Vavouri, Ano Kleidonia and in Drama (Fig. 29). According to Sakis Drosopoulos† it is present also on the island of Kalymnos (Gogala & Drosopoulos, 2006), but according to our present knowledge about a distribution of cicadas on both sides of the Rechinger line (Gogala & Trilar, 2014) this should be checked again. Data about the presence of this species in Western Europe and in Northwestern Africa are very doubtful (Puissant & Sueur, 2010; Puissant, unpublished data).

The calling song of *M. flaveola* comb. nova was described some years ago by Gogala & Drosopoulos (2006). Additional comparative information on morphology and the song characteristics are given also in this paper (Fig. 23).

We should add that this species is found usually in meadows on grass (Figs. 6, 7), other herbaceous plants and on small shrubs. We found it in the time period from June 9 till July 16 (according to the data from our collection and song recordings).

***Mezammira tibialis* (Panzer, 1798) comb. nova**

Tettigonia tibialis Panzer, 1798.
Cicada (*Tettigetta*) *tibialis* (Panzer, 1798): Kolenati (1857).
Cicadetta tibialis (Panzer, 1798): Szilády (1870).
Melampsalta tibialis (Panzer, 1798): Stål (1866).
Pauropsalta tibialis (Panzer, 1798): Distant (1906), Lodos & Kalkandelen (1981).
Tettigetta tibialis (Panzer, 1798): Kirkaldy (1908).
Cicadivetta tibialis (Panzer, 1798): Boulard (1982a , 1995), Puissant (2006), Puissant & Sueur (2010), Gogala et al. (2012).
Cicadetta tibialis (Panzer, 1798): Emelyanov (1996), Popov (1997).
[*Oligoglena libanotica*: Dlabola (1959) *non* Horváth (1911). Misidentification.]
= *Cicada* (*Tettigetta*) *tibialis* (Panzer, 1798) *caucasica* Kolenati, 1857 **syn. nov.**
[under the name *Melampsalta* (*Pauropsalta*) *tibialis caucasica* (Kolenati, 1857) *in*: Oshanin (1912)];
[under the name *Cicadetta caucasica* (Kolenati, 1857) *in*: Schumacher (1922), Metcalf (1963), Nast (1972), Duffels & Van der Laan (1985) and Sanborn (2014)].
= *Cicada tibialis minor* Eversmann (1859): Nast (1972).
= *Cicada tibialis imbecillis* Eversmann (1859) **syn. nov.**: Schumacher (1922), Nast (1972), under the name *Cicadetta caucasica* (Kolenati, 1857).
= *Cicadetta sareptana* Fieber, 1876 **syn. nov.**: Schumacher (1922), Nast (1972) under the name *Cicadetta caucasica* (Kolenati, 1857).
= *Cicadetta transylvanica* Fieber, 1876: Boulard & Mondon (1996), Puissant (2006).
= *Cicadetta cissylvanica* Haupt, 1935: Dlabola (1963), Lodos & Kalkandelen (1981).

Gogala et al. (1996) and Popov (1997) reported that they did not find any important difference in acoustic traits between *M. caucasica* comb. nova from Southern Caucasus and *M. tibialis* comb. nova from Slovenia. Emelyanov (1996) studied the morphology of both taxa and suggested the synonymy. Therefore *M. caucasica* comb. nova is considered as a junior synonym of *M. tibialis* comb. nova.

MORPHOLOGY. Figs. 8, 11a, 26a, 31c.

DISTRIBUTION. *Mezammira tibialis* comb. nova is, like *M. flaveola* comb. nova, mentioned in the literature in many countries belonging to the Mediterranean or Asian area (see Metcalf, 1963; Duffels & Van der Laan, 1985 and Sanborn, 2014 for more precision). Like *M. flaveola* comb. nova*, M. tibialis* comb. nova is not present either in Portugal and Spain (Sueur et al., 2004; Puissant, unpublished data) and this species was probably misidentified in these countries with species belonging to the genus *Tympanistalna* Boulard, 1982 (Puissant, unpublished data). The western limit of its distribution area is in France, precisely in the extreme south-east part of the country in the Alpes-Maritimes department (Puissant, 2006). This species was not found in the Maghreb area (Puissant, unpublished data) and its east and north-east area limits need to be confirmed. In the present state of our knowledge *M. tibialis* comb. nova is widely distributed in southern Europe and was just recently (29. 5. 2016) for the first time found in Greece in Central Macedonia near Litochoro (Gogala & Trilar, unpublished data) (Figs. 8, 29). The calling song was first described by

Fig. 8: *Mezammira tibialis* comb. nova from Litochoro, Greece.

Fig. 9: *Mezammira carayoni* comb. nova from Rethymno, Crete.

Boulard (1995) and in more details by Gogala et al. (1996) and Sueur & Puissant (2000).

***Mezammira carayoni* (Boulard, 1982) comb. nova**

Tettigetta carayoni Boulard, 1982b.

Tettigetta carayoni Boulard, 1982b: Trilar & Gogala (2010).

Cicadivetta carayoni (Boulard, 1982b): Puissant & Sueur (2010), Gogala, Drosopoulos & Trilar (2012).

MORPHOLOGY. Figs. 9, 11c, 26d, 31b.

DISTRIBUTION. *Mezammira carayoni* comb. nova is an endemic species of Crete (Fig. 29). Boulard described this species from the material collected by the French entomologist Jacques Carayon (1982b). The calling song was described by Trilar & Gogala (2010) and is similar to the calling song of *M. flaveola* comb. nova. This species is common in Crete from the seacoast to the highest localities and has not been found anywhere else. The type material was collected on 5th June (Boulard, 1982b) and we found *M. carayoni* in the time period from June 27 to July 3.

***Mezammira goumenissa* (Gogala, Drosopoulos & Trilar, 2012) comb. nova**

Cicadivetta goumenissa Gogala, Drosopoulos & Trilar, 2012.

MORPHOLOGY. Figs. 10, 11b, 26b, 31d.

Fig. 10: *Mezammira goumenissa* comb. nova, Mt. Panachaiko.

DISTRIBUTION. *Mezammira goumenissa* comb. nova is an endemic species of Greece (Fig. 29). This cicada was described recently (Gogala et al., 2012) and is restricted to a very small area in the Northern Peloponnese around the village of Goumenissa in localities at 700±50 m ASL. Imagoes were flying and singing there in the time period from June 9 to 28 (Gogala et al. 2013). However, we found this species later, on June 30 2015 also on Mt. Panachaiko in localities from 700 m up to 1300 m (Gogala & Trilar, unpublished data). The calling song of this species was described by Gogala et al. (2012, 2013).

Other taxa assigned to the genus *Mezammira*, not reported from Greece

The subspecies *Cicadetta tibialis acuta* Dlabola, 1961, synonymised with *Mezammira tibialis* (Panzer, 1798) by Nast (1972) (as *Cicadetta tibialis*), does not belong to the genus *Mezammira*. After examination of the three males of the type series deposited in the MNHN, the taxon described by Dlabola (1961) belongs in fact to the genus *Tettigetta* Kolenati, 1857: *Tettigetta acuta* (Dlabola, 1961) **comb. nova, stat. nov.** This species is known from Uzbekistan and the former Soviet Union (Dlabola, 1961).

***Mezammira parvula* (Fieber, 1876) comb. nova**

Cicadetta parvula Fieber, 1872: ***nomen nudum***.

Cicadetta parvula Fieber, 1876 [*non Cicada parvula* Say, 1825 ***nomen praeoccupatum***: Kirkaldy (1909), Davis (1920) = *Cicadetta calliope* (Walker, 1850)].

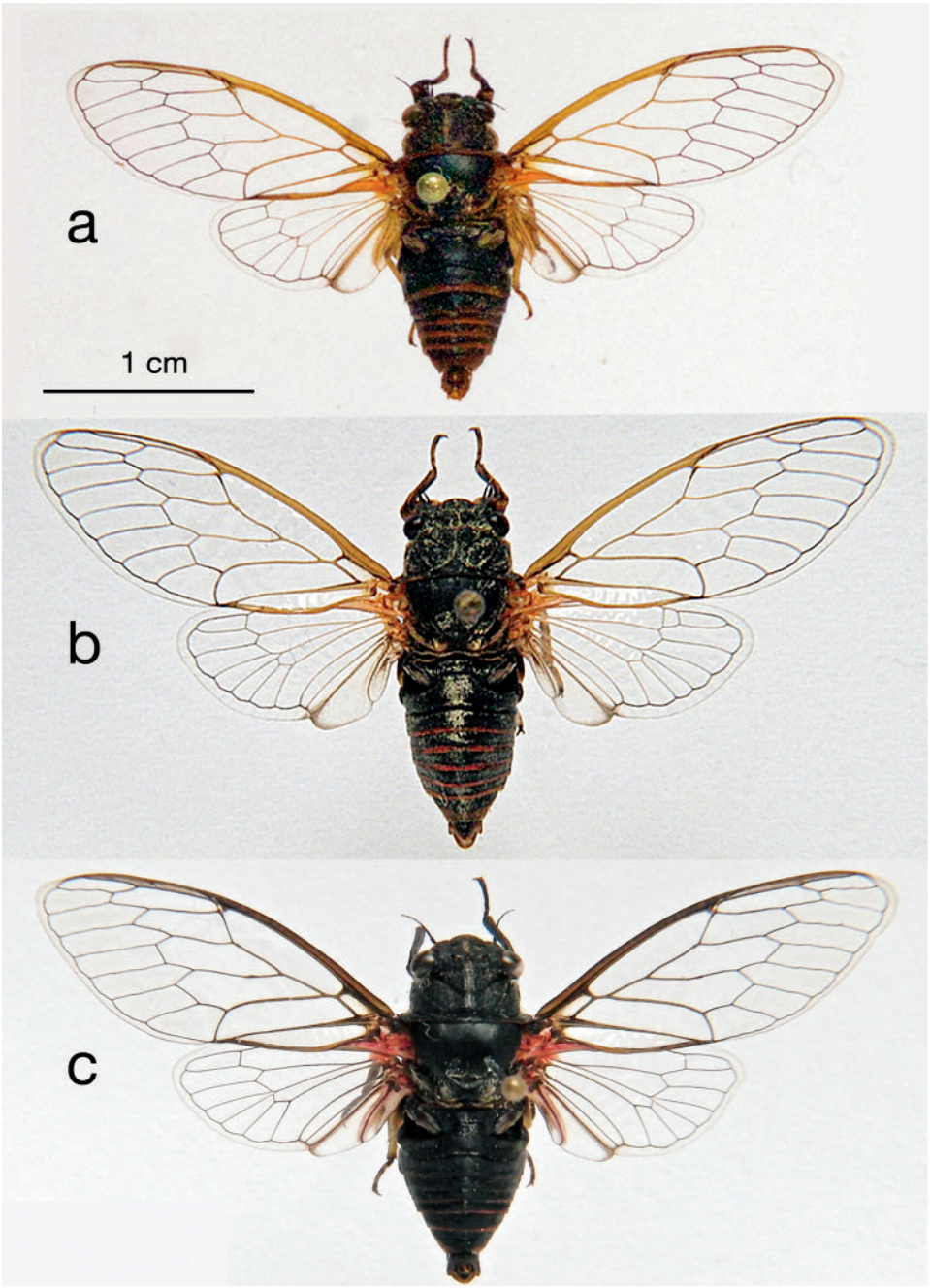

Fig. 11: Habitus of *Mezammira* species of Greece: a - *M. tibialis* comb. nova, b - *M. goumenissa* comb. nova, c - *M. carayoni* comb. nova

Melampsalta parvula (Fieber, 1876): Uhler (1888).
Tettigetta parvula (Fieber, 1876): Schedl (1999).
Cicadivetta parvula (Fieber, 1876): Puissant & Sueur (2010).
= *Cicadetta fieberi* Oshanin, 1908: Nast (1972), Lodos & Kalkandelen (1981).
= *Cicadetta fieberi* Kirkaldy, 1909: primary homonym, Nast (1972), Lodos & Kalkandelen (1981).
= *Oligoglena libanotica* (Horváth, 1911): Schedl (1999). Type in Natural History Museum in Budapest examined by Schedl (1999).

DISTRIBUTION. Turkey (Fieber, 1876; Nast, 1972; Lodos & Kalkandelen, 1981; Kemal & Koçak, 2010), Asia Minor (Oshanin, 1906), Lebanon (Horváth, 1911), Israel (Schedl, 1999). The presence of this species in Morocco (Nast, 1972; Lodos & Kalkandelen, 1981) is very doubtful (Puissant, unpublished data).

***Mezammira sibilatrix* (Horváth, 1901) comb. nova**

Cicadetta sibilatrix Horváth, 1901.
Pauropsalta sibilatrix (Horváth, 1901): Distant (1906).
Melampsalta sibilatrix (Horváth, 1901): Fahringer (1922).
Cicadivetta sibilatrix (Horváth, 1901): Gogala, Drosopoulos & Trilar (2012, 2013).

DISTRIBUTION. Turkey (Horváth, 1901; Fahringer, 1922; Nast, 1972; Lodos & Kalkandelen, 1981; Kemal & Koçak, 2010), Asia Minor (Horváth, 1901), Syria (Schumacher, 1923; Nast, 1972; Lodos & Kalkandelen, 1981), Lebanon (Schumacher, 1923), Israel (Schumacher, 1923; Nast, 1972; Lodos & Kalkandelen, 1981).

***Mezammira iphigenia* (Emelyanov, 1996) comb. nova**

Cicadetta iphigenia Emelyanov, 1996 [holotype and one paratype examined with photos of Vladimir Gnezdilov, Zoological Institute, Saint-Petersburg Collection].

DISTRIBUTION. Crimea (Emelyanov, 1996; Trilar et al., 2006), Romania (Trilar et al., 2006; Trilar & Gogala, 2008).

***Mezammira popovi* (Emelyanov, 1996) comb. nova**

Cicadetta popovi Emelyanov, 1996.

DISTRIBUTION. Tadzhikistan (Emelyanov, 1996; Popov, 1997).

***Mezammira turcica* (Schedl, 2001) comb. nova**

Tettigetta turcica Schedl, 2001.

DISTRIBUTION. Turkey (Schedl, 2001; Kemal & Koçak, 2010).

DESCRIPTION OF NEW TAXA

***Mezammira filoti* Gogala & Trilar sp. nova,**
morphology, acoustics, distribution

Type material: HOLOTYPUS + PARATYPUS 1-3 (♂♂), white labels: GR: Naxos: Filoti, 22.6.2014, 436 m, N37°02.484', E25°29.690', T.Trilar, M.Gogala leg.; PARATYPUS 4 (♂) and PARATYPUS 5 (♀): GR: Naxos: Filoti, 21.6.2014, 436 m, N37°02.487', E25°29.685', T.Trilar, M.Gogala leg.

Red labels: HOLOTYPUS/ *Mezammira filoti/* Gogala & Trilar 2017
PARATYPUS X/ *Mezammira filoti/* Gogala & Trilar 2017

The holotype and paratypes are deposited in the Slovenian Museum of Natural History (Ljubljana, Slovenia).

Morphology. Figs. 12-14, 26f.

Measurements - Body length, males (5): 12.04-13.69 mm, female (1): 12.04 mm.

Dorsal side

Head - Black with yellow markings. Median furrow on vertex (epicranial suture), front edge of the supra-antennal plates and median line on vertex yellow. Compound eyes in living animals reddish brown (Fig. 13).

Thorax - Pronotum black, pronotal collar broadly yellow, laterally darker, anterior edge and median line also yellow. Dark basal spot on pronotal collar diagonally connected with both black fields (Figs. 14a, 26f). Mesonotum black, lateral edges yellow. Fields between the cruciform elevation and the wing grooves pale yellow. Metanotum with black patch in the middle, laterally yellow (Fig. 14a).

Wings - Measurements: FL = 12.3±0.6, FW = 5.0±0.3, FL/FW = 2.5±0.1.

Wings hyaline, basal part of veins yellow to brown, distally black. Forewing veins M and CuA at the basal cell completely fused, fused stem 0.85-1.5 times as long as arculus. Number of apical cells on forewings 7 in the holotype and 7 or 8 in paratypes, on hindwings 5 (holotype), in two paratypes 6 on one side. Ulnar cells on forewings 1.36-2.33 times longer than apical cell 1. Apical cell a2 on hind wings larger than others.

Abdomen - Tergum black, distal edges of tergites reddish brown to yellow. Males: timbals with two long and two short ribs in addition to the timbal plate (Fig. 14c).

Female: Habitus similar to the males, except genital abdominal structures. Tergum dark, segments caudally yellow and reddish brown. Tergites t8 and ab9 at the sides broadly pale yellow (Figs. 14e, 14g).

Genitalia - Males: Pygofer yellow, darker at the base, dorsally black with black pointed dorsal beak. Upper lobe elongated, whitish or pale yellow. Basal lobe also pale yellow with darker inner tooth. Median lobe of uncus short, rounded. Claspers hooked anterolaterad, dark brown toward the tip. Pseudoparameres short, flattened, not pointed at the tip (Fig. 14b).

Ventral side

Head - Black, lateral edge of postclypeus brown. Rostrum brown with yellow menthum, reaching the posterior tips (distal end) of middle trochanters.

Thorax - Prosternum pale yellow with brown markings. Sternum yellow with dark patches. Males: Operculum and meracanthus yellow, in some paratypes darker at the base.

Legs - Coxae yellow with dark brown longitudinal patches. Front femora with primary and 3 secondary spines, female specimen with two secondary spines. Spines and their basis brown with one dark brown patch under the primary spine extending to trochanter. Medial side of front femora brown. Trochanter yellow and brown. Front tibiae brown, first tarsal segment yellow, metatarsus dark, claws yellow and darkened toward the tip. Mid and hind legs yellow with dark brown longitudinal patches, femora on the ventral side with a short dark line and frontally with a long dark line.

Abdomen - Sternites III-VI pale yellow, posterior edges red and yellow. Also sternite VIII pale yellow, slightly shorter or the same length as sternite VII. Sternites I, II and VII

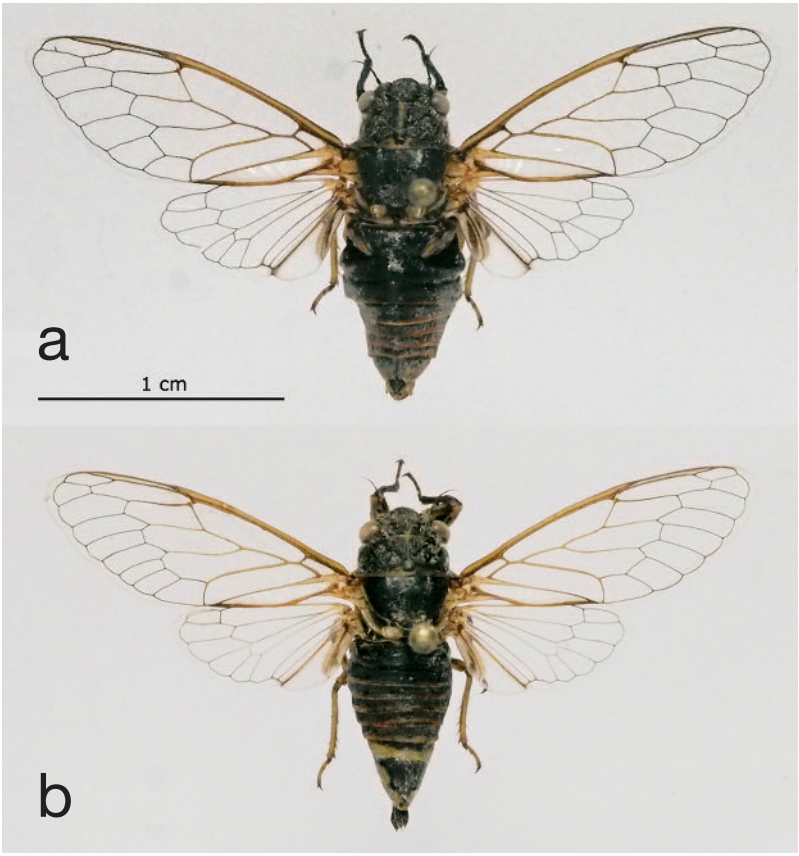

Fig. 12: *Mezammira filoti* sp. nova: a - holotype, b - female paratype 5.

Fig. 13: *Mezammira filoti* sp. nova from Naxos island.

darker (gray). Abdominal sternites III to VI pale yellow, sternite VII pale yellow with dark patch on each side. Females: Ovipositor brown, darker toward the tip. Gonocoxites IX-X dark brown (Figs. 14e, 14g). Ovipositor length is 38% of the body length.

Acoustic behaviour

Calling song - The calling song of this species is very similar to the song of *M. flaveola* comb. nova comprising two phrases, A and B. Phrase A is composed of fast repeating echemes of medium duration (MMM...) with the repetition rate 7.7-8.7 Hz. Singing animals periodically switch to phrase B with groups of longer (L) and a few very short echemes (S) inbetween (LSSLSSLSS...) (Figs. 15, 16). There is no interruption in song between phrases. The duration of echemes in phrase A is 25.8±4.3 ms (n=280) and the interval between them 98.7±6.5 ms (n=273). In phrase B the duration of L is 87.5±42.1 ms (n=213) and the duration of S is 7.7±4.5 ms (n=346). The duration of intervals in the phrase B is 83.6±25.3 ms (N=602). The number of long echemes in phrase B varies very much from a few L to 30 or 50 but the number of S echemes inbetween L echemes is very stable: 2, occasionally 1 or 3.

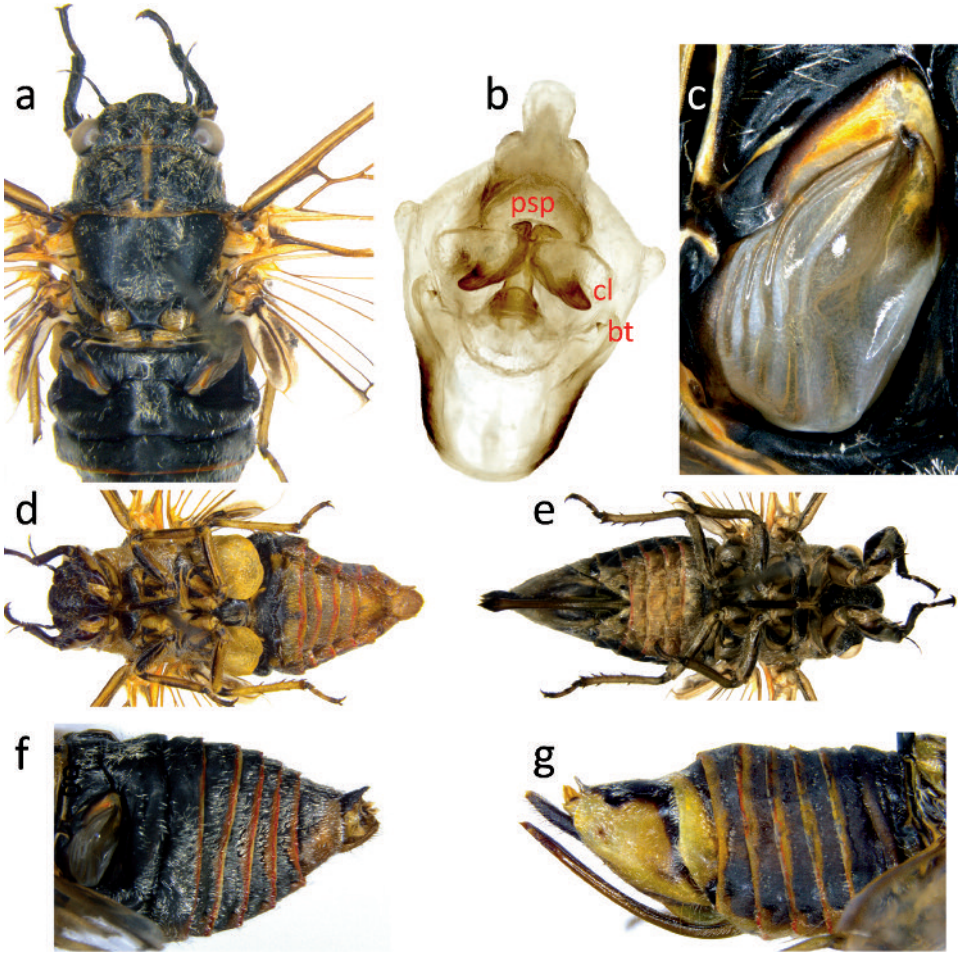

Fig. 14: *Mezammira filoti* sp. nova: a - body details of the holotype; b - male genitalia: psp - pseudoparameres, cl - claspers, bt - inner tooth on the basal lobe of pygofer; c - left timbal; d - male holotype, ventral side; e - female paratype 5, ventral side; f - lateral view of the male abdomen (holotype); g - lateral view of the female abdomen, paratype 5.

The carrier frequency of the calling song is in both phrases the same in the range of 10.8-17.8 kHz (5% limit - 95% limit) with the center frequency of 13.9 kHz (Table 3, Figs. 15, 27).

Etymology

We named this species after the village Filoti on the island of Naxos, where we found the only population of this new species.

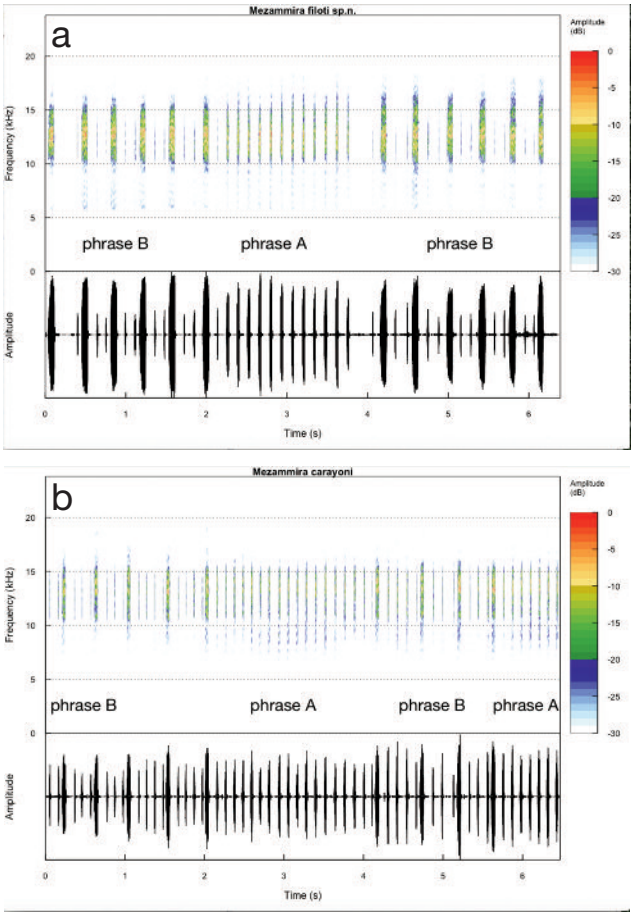

Fig. 15: *Mezammira filoti* sp. nova: a - Oscillogram and spectrogram of the selected part of the calling song with phrase B (0-2s, 4-6.5s) and phrase A (2-4s); b - song selection of *M. carayoni* comb. nova of similar length for comparison.

Distribution and Ecology

We found this species on the island of Naxos, but only in one locality with phrygana (garigue) vegetation near the village Filoti on the steep slope oriented to the northwest above the main road between Filoti and Apeiranthos. The locality is from the northwest surrounded by cultivated fields and gardens and from the other side by the steep rocky slope (Fig. 18). Anywhere else on the island we found only *Cicada orni* Linnaeus, 1758 and *Euboeana castaneivaga* Gogala, Trilar & Drosopoulos, 2011 (Fig. 17, unpublished data). *Euboeana castaneivaga* was described previously from the island of Evia and found later on the island of Andros (Gogala & Trilar, 2014). It is possible, that *M. filoti* sp. nova could in the future be found also in some

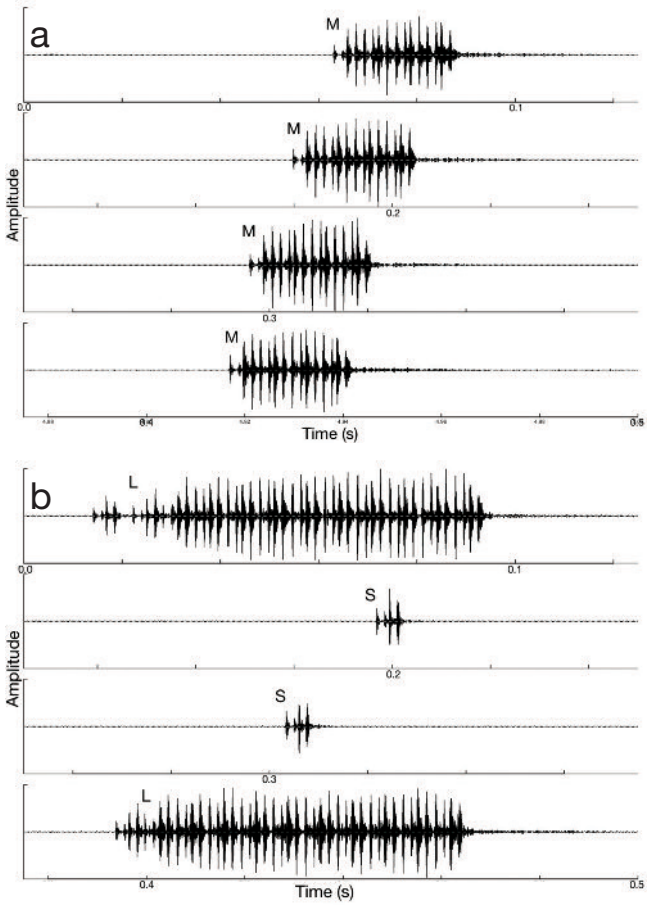

Fig. 16: *Mezammira filoti* sp. nova: Examples of phrase A with echemes MMM (a) and phrase B with a sequence LSSL (b) in extended time scale.

other localities on Naxos or on other islands of the Cyclades, but at present we know only the single locality, described above.

Due to the small (probably residual) population of *M. filoti* sp. nova its habitat should be protected by law.

***Mezammira sakisi* Gogala & Trilar sp. nova**
morphology, acoustics, distribution

Type material: HOLOTYPUS, the white label: GR: Peloponnese: Laconia, Evrotas, Kremasti, Mt.Chionovouni, 26.6.2015, 867 m, N36.98611˚ E22.90383˚, T.Trilar, M.Gogala leg.; PARATYPUS 1-10 (♂♂), 12-14 (♀♀), the white labels: GR: Peloponnese: Laconia, Evrotas, Kremasti, 26.6.2015, 915 m, N36.96796˚, E22.88843˚,

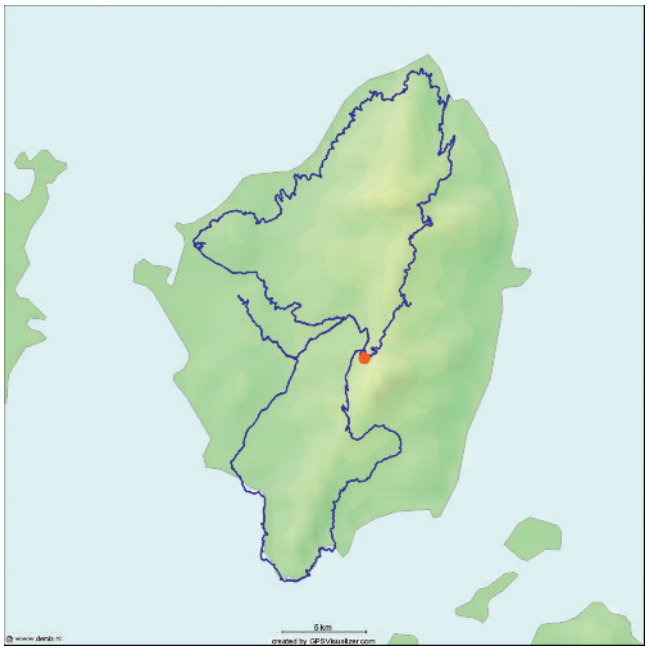

Fig. 17: Type locality of *Mezammira filoti* sp. nova (red dot) and tracks of our field research on Naxos.

Fig. 18: Habitat of *Mezammira filoti* sp. nova with phrygana vegetation near the village Filoti, island of Naxos.

T.Trilar, M.Gogala leg.; PARATYPUS 11 (♂) GR: Peloponnese: Laconia, Evrotas, Apidia, 26.6.2015, 225 m, N36.86963˚, E22.81469˚, T.Trilar, M.Gogala leg.

The red labels: HOLOTYPUS/ *Mezammira sakisi/* Gogala & Trilar 2017
PARATYPUS XX/ *Mezammira sakisi/* Gogala & Trilar 2017

The holotype and paratypes are deposited in the Slovenian Museum of Natural History (Ljubljana, Slovenia).

Morphology. Figs. 19-21, 26e.

Measurements - Body length, males (12): 11.6±0.7 mm, females (3) 11.6-13.7 mm.

Dorsal side

Head - Black with yellow markings. Median furrow on vertex (epicranial suture), anterior edge of the supra-antennal plates, a dot at the anterior part yellow. Compound eyes in living animals black (Fig. 20).

Thorax - Pronotum black, hind edge of pronotal collar and frontal edge of pronotum reddish brown or yellow, laterally darker, the median line brown or yellow (Figs. 21a, 26e). No dark median spot on pronotal collar.

Mesonotum black, lateral and hind edges yellow. Fields between the cruciform elevation and the wing grooves and further the lateral edge brown to pale yellow. Hind edges of metanotum yellow or lighter than ground color. Body parts covered with silvery hairs, longest ones behind the compound eyes and around the cruciform elevation.

Abdomen - Tergum black, distal edge of tergites reddish brown. Males: timbals with two long and two short ribs in addition to the timbal plate (Fig. 21c).

Wings - Measurements: FL = 12.7±0.9, FW = 5±0.3, FL/FW = 2.5±0.1 (N=30).

Wings hyaline, forewing veins M and CuA at the basal cell completely fused, fused stem 1.47±0.4 times longer than arculus. Number of apical cells on forewings 8 (in 2 paratypes unilaterally 9), on hindwings 5 (in 4 paratypes 6 on one side). Ulnar cell on forewings 1.36±0.11 times longer than apical cell 1.

Ventral side

Head - Black, lateral edge of postclypeus yellow. Rostrum extends slightly beyond the middle trochanters. Proximal part of antennae black, distally whitish.

Thorax - Thoracic sternum black with yellow markings. Males: Opercula reniform, gray, hind part lighter. Meracanthus triangular, edges curved upward, yellow.

Legs black, brown and yellow. Middle and hind femora black, with hind side yellow. In lighter specimens at the base, a short dark line and black longitudinal patch ventrally. Fore femora black with lateral yellow longitudinal fascia, median side brown. All legs with many hairs, tibia with spurs as well. Fore femora with primary and three secondary spines.

Abdomen - Sternites III-VII yellowish, in the middle proximal part often darker. Sternite VIII yellow, slightly shorter than sternite VII (stVIII/stVII = 0.8±0.1 (n=12)). Sternites I and II dark. Epipleurites gray, except the yellow hind and inner edge.

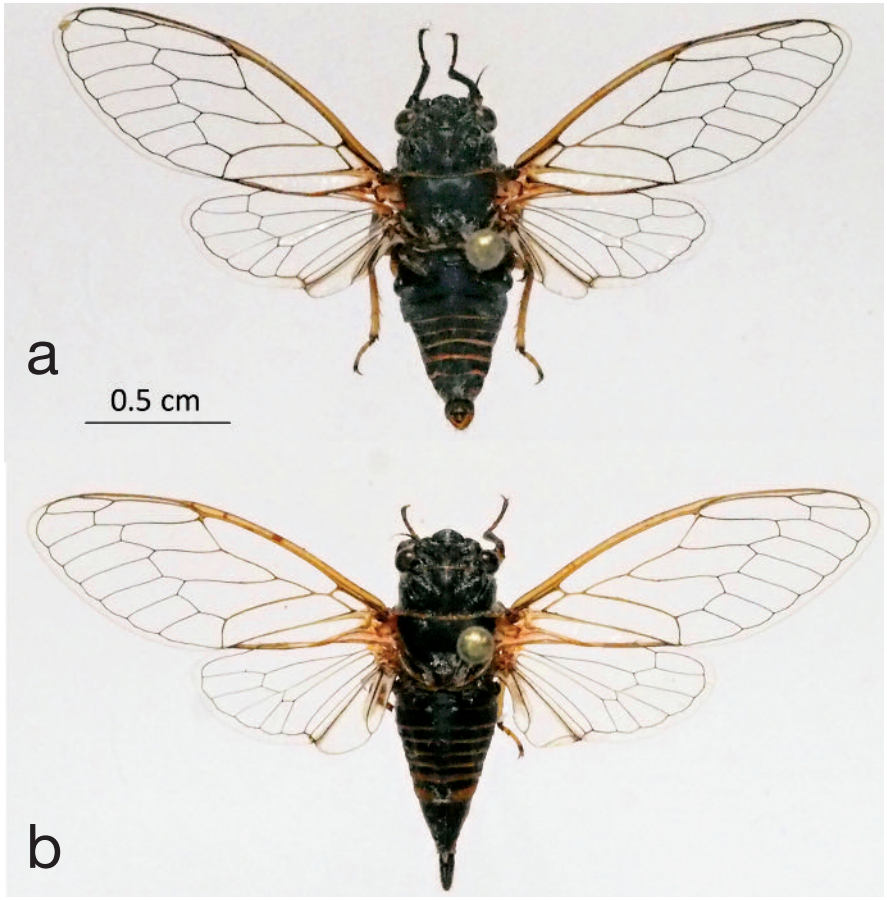

Fig. 19: *Mezammira sakisi* sp. nova: a - male holotype, b - female paratype 13.

Genitalia - Males: Very similar traits as in *M. filoti* sp. nova. Cylindrical inner tooth on the basal lobe present, dorsal beak sharp, claspers pointed anterolaterad, pseudoparameres flat, short and not pointed at the tip (Fig. 21b).

Females: Sternite VIII without dark spot (Fig. 21e). Ovipositor extends further behind the tip of tergite 9 as compared to the related species (e.g. *M. filoti*). The length of the ovipositor is 34% of the body size (Figs. 19b, 21e, 21g).

Acoustic behaviour

Calling song - The calling song of *M. sakisi* sp. nova (Fig. 22) is similar to the song of *M. flaveola* comb. nova (Fig. 23) with fast repetition of short echemes of different durations. The song is comprised of phrases of three different patterns, which change randomly without interruption through many minutes. We keep the designation of phrases (A, B, C) as in the paper describing the song of *M. flaveola* comb. nova (Gogala & Drosopoulos, 2006).

Fig. 20: *Mezammira sakisi* sp. nova on Kermes Oak (*Quercus coccifera*).

The simplest pattern or phrase A is the repetition of the same type of echemes (MMM...). In *M. sakisi* sp. nova the duration of echemes in phrase A is 33.1±5.1 ms (n=718). The intervals between echemes last in this phrase 80.3±9.1 ms (n=720) (Table 2, Fig. 22, 24).

The second pattern in phrase B is composed of groups of long echemes (L) with intervals filled in most cases with three very short echemes (LSSSLSSSL...) (Figs. 22, 24). The duration of long echemes in phrase B is 69.6±8.6 ms (N=278), and of the short ones 11.4±4.9 ms (n=950). The shortest echemes in this phrase consist of only one syllable with 4 timbal clicks as in the case of *M. filoti* sp. nova (see above and Fig. 24). The average interval duration between echemes in this phrase is 75.1±17.8 ms (n=944) with the exception of the last interval preceding the long echeme, which lasts 44.6±10.2 ms (n=280). The number of long echemes in the groups of the phrase B ranges from 3 to more than 15 (median 5).

The third pattern or phrase C comprises just the long sequences of alternating long and short echemes (LSLS...) or long and two short echemes (LSSLSS…). The duration of long echemes in this phrase is 83.1±8.8 ms (n=762) and of short echemes 20.3±4.7 ms (N=818). The average interval between echemes in such sequences is 42.5±10 ms (n=1578) and the repetition rate of echemes is 10.5 Hz (Fig. 22).

The time parameters presented above represent the calling song of animals, recorded in the **Eastern Peloponnese**.

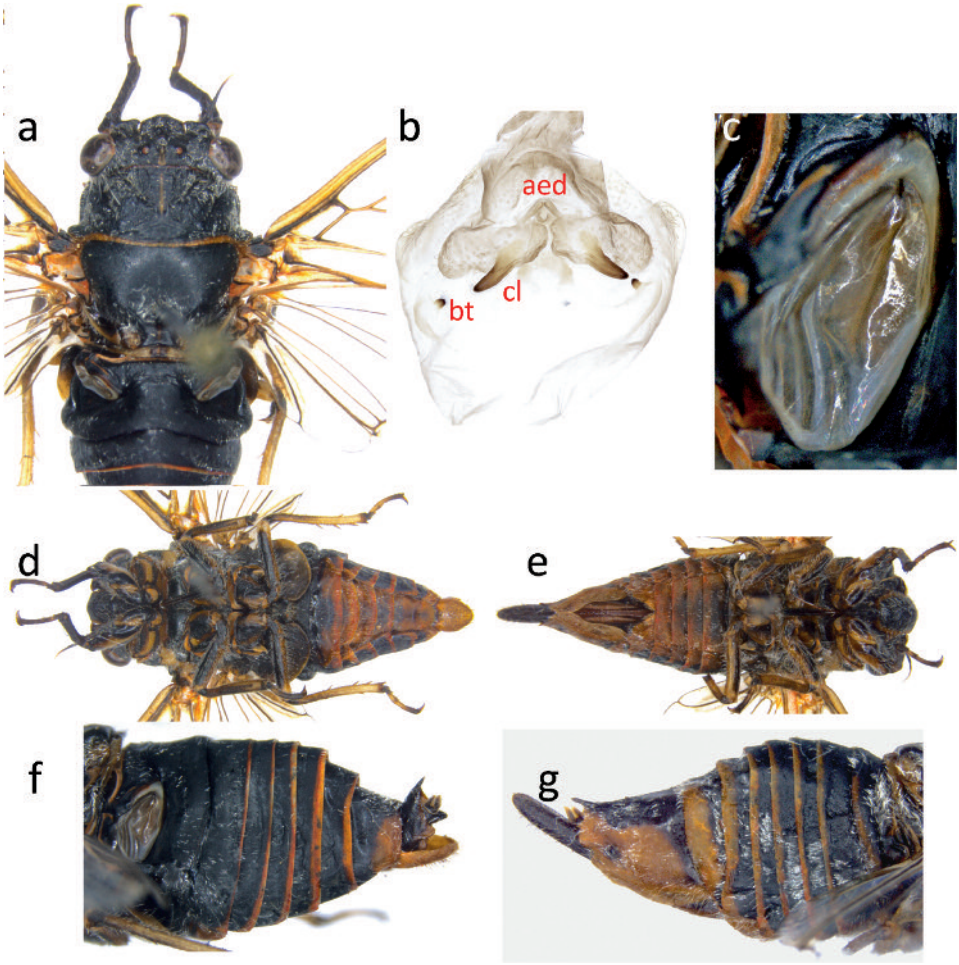

Fig. 21: *Mezammira sakisi* sp. nova: a, c, d, f – holotype, e, g – female paratype 13; a - body details of the holotype; b - male genitalia: aed - tip of aedeagus with pseudoparameres and a gonopore, cl - claspers, bt - inner tooth on the basal lobe of pygofer; c - left timbal; d - male holotype, ventral side; e - female paratype 13, ventral side; f - lateral view of the male abdomen (holotype); g - lateral view of the female abdomen, paratype 13.

The most important parameter in the calling song of *M. sakisi* is the carrier frequency, which is the same in all phrases. The center frequency of the recordings from the Eastern population is 18.7±0.5 kHz (n=20), with the lower (5%) limit at 16.7±1.7 kHz (n=20) and higher (95%) limit at 20.7±0.7 kHz (n=20) (Table 3, Fig. 27). These values are in both populations much higher as compared to the frequency range and center frequency of sympatric *M. flaveola* comb. nova (Table 3, Fig. 27).

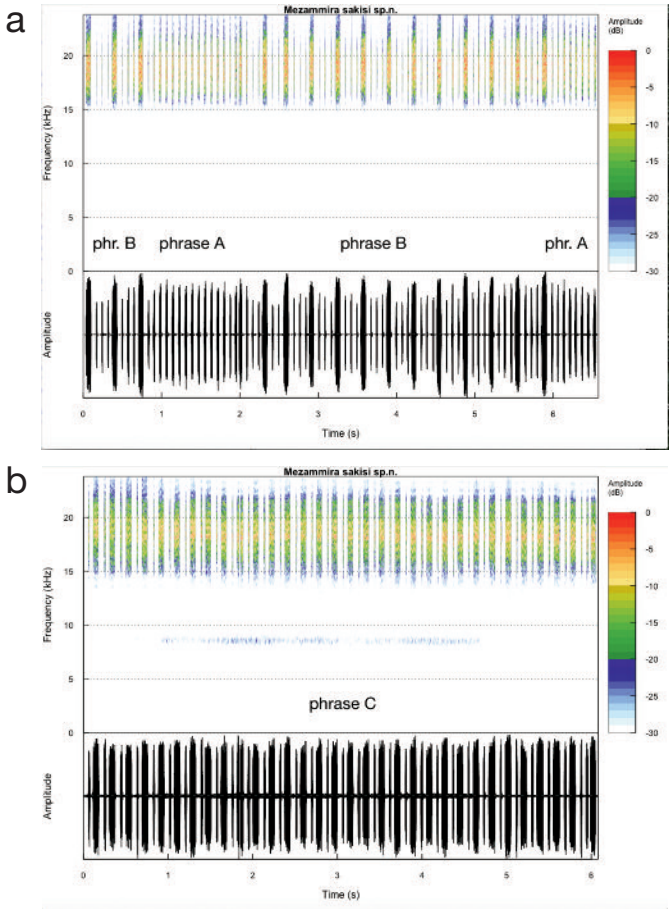

Fig. 22: Oscillogram and spectrogram of the selection in the calling song of *Mezammira sakisi* sp. nova with phrases A (0.8-2 s, 6-6.5 s) and B (0-0.8 s, 2-6 s) (a) and phrase C (b).

Etymology

The name of this species, *Mezammira sakisi* sp. nova, is devoted to the memory of our friend and excellent biologist Prof. Athanasios (Sakis) Drosopoulos†, who lead us to many most interesting habitats in his country and importantly shared our research on cicadas. He passed away on March 30th 2014 (Hoch et al., 2015).

Distribution and Ecology

We found *M. sakisi* sp. nova in the hills and mountains of Eastern Peloponnese from Ag. Andreas and Korakovouni, around Mt. Chionovouni and Mt. Madara to the Apides in the South East (Fig. 29). The animals were usually sitting and hiding in small shrubs (e.g. *Quercus coccifera,* Figs. 20, 25).

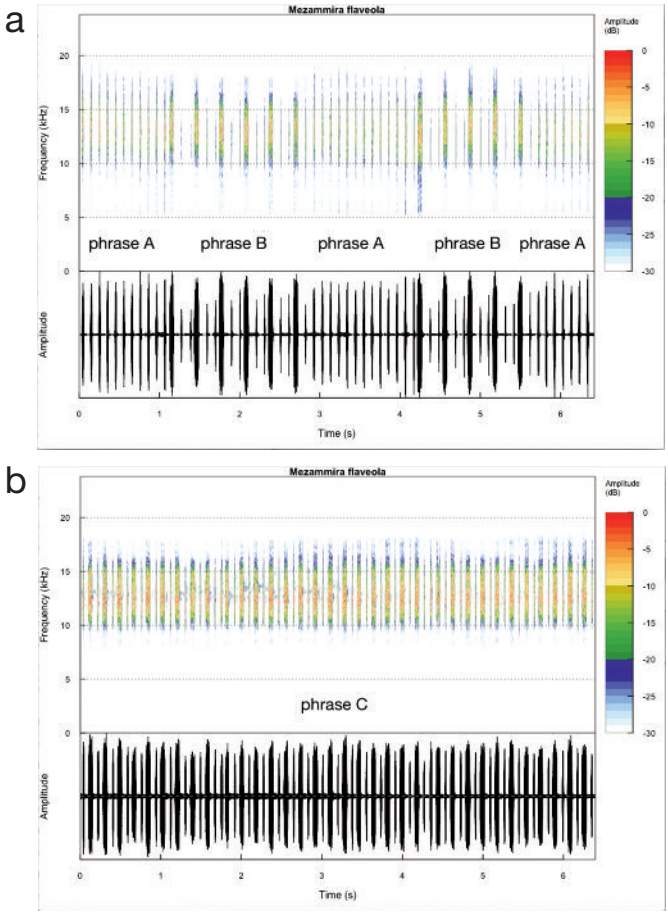

Fig. 23: *Mezammira flaveola* comb. nova phrase A and B (a) and phrase C (b). Shown is similar selection as in Fig. 22 - see the differences in carrier frequency range of the song as compared to the range of *M. sakisi* sp. nova (Fig. 22)!

Discussion

Comparison of all species present in Greece
with keys for discrimination by morphological and acoustic traits.

Cicadas of the genus *Mezammira* in Greece are represented, according to our present knowledge, by the following species: *M. flaveola* comb. nova (Figs. 4, 6), widely distributed and abundant species on Peloponnese and in some localities in central and northern Greece, *M. tibialis* comb. nova (Figs. 8, 11a), very common species in the entire southern part of Europe except Spain and Portugal, but only recently found near Litochoro in northern Greece, *M. carayoni* comb. nova (Figs. 9, 11c), the endemic

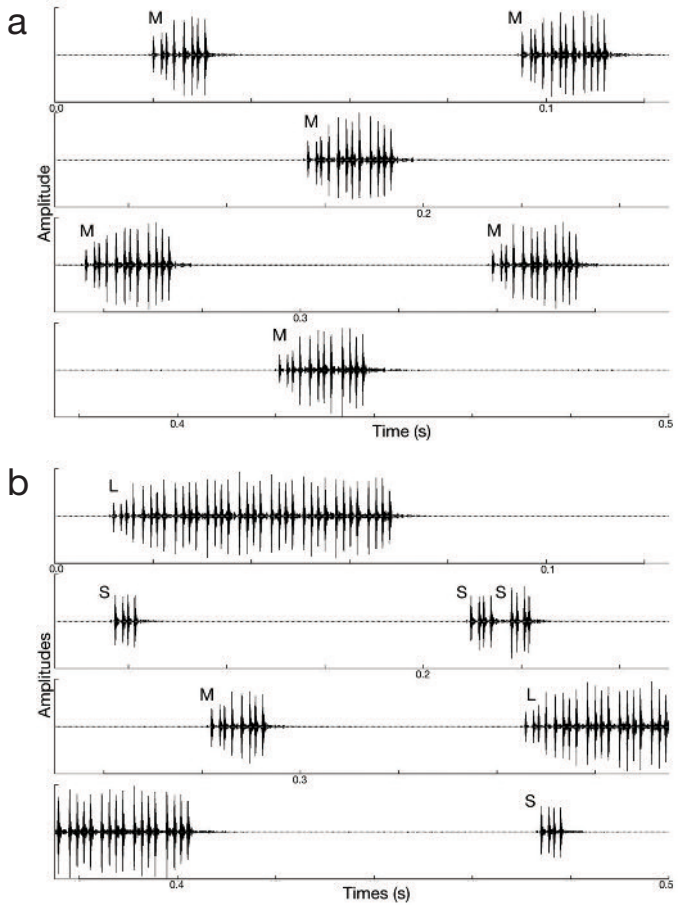

Fig. 24: *Mezammira sakisi* sp. nova: Examples of phrase A with echemes MMMMM (a) and phrase B with a sequence LSSMLS (b) in extended time scale.

species of Crete, and the recently described species from northern Peloponnese, *M. goumenissa* comb. nova (Figs. 10, 11b). In this paper we are describing two new species, *M. filoti* sp. nova from the island of Naxos and *M. sakisi* sp. nova, discovered in some localities on Peloponnese. After the comparison of morphological and acoustical traits we found many similarities but also differences among this group of species.

Similarities:

The common **morphological characteristics** show clearly, that all compared species belong to the same genus. These cicadas are small, with body length between 11.5-15.5 mm. Pygofer is dorsally beak shaped and is bearing an inner tooth on the basal lobe.

Fig. 25: Habitat of *Mezammira sakisi* sp. nova near Mt. Madara and village Kremasti in the Eastern Peloponnese.

Upper lobe is elongated, uncus is small, not prominent and semicircular or duck-bill shaped.

Pointed claspers are oriented anterolaterad, pseudoparameres are flat and not very long (with exception of *M. tibialis* comb. nova and *M. goumenissa* comb. nova, Figs. 31c, 31d). Sternite VIII is shorter or of similar length as sternite VII. Veins M and CuA on forewings are meeting the basal cell with stems completely fused. The number of apical cells in the forewings is in most species 8 (with exception of *M. filoti* sp. nova - 7), sometimes unilaterally 7 or 9, and on the hindwings 5 (unilaterally 3 - 6!). Exceptions are *M. carayoni* comb. nova and *M. goumenissa* comb. nova with 6 apical cells on the hind wings (Figs. 11b, 11c) (Boulard, 1982b; Gogala et al., 2012).

The common **acoustic trait** in the calling songs of Greek *Mezammira* species is fast repetition of short echemes of different durations in specific phrases, which are switching without interruption from one into the other (Figs. 15, 16, 22-24, 30). The only exceptions among Greek *Mezammira* species are again *M. tibialis* comb. nova and *M. goumenissa* comb. nova. For *M. tibialis* comb. nova, the longer duration M

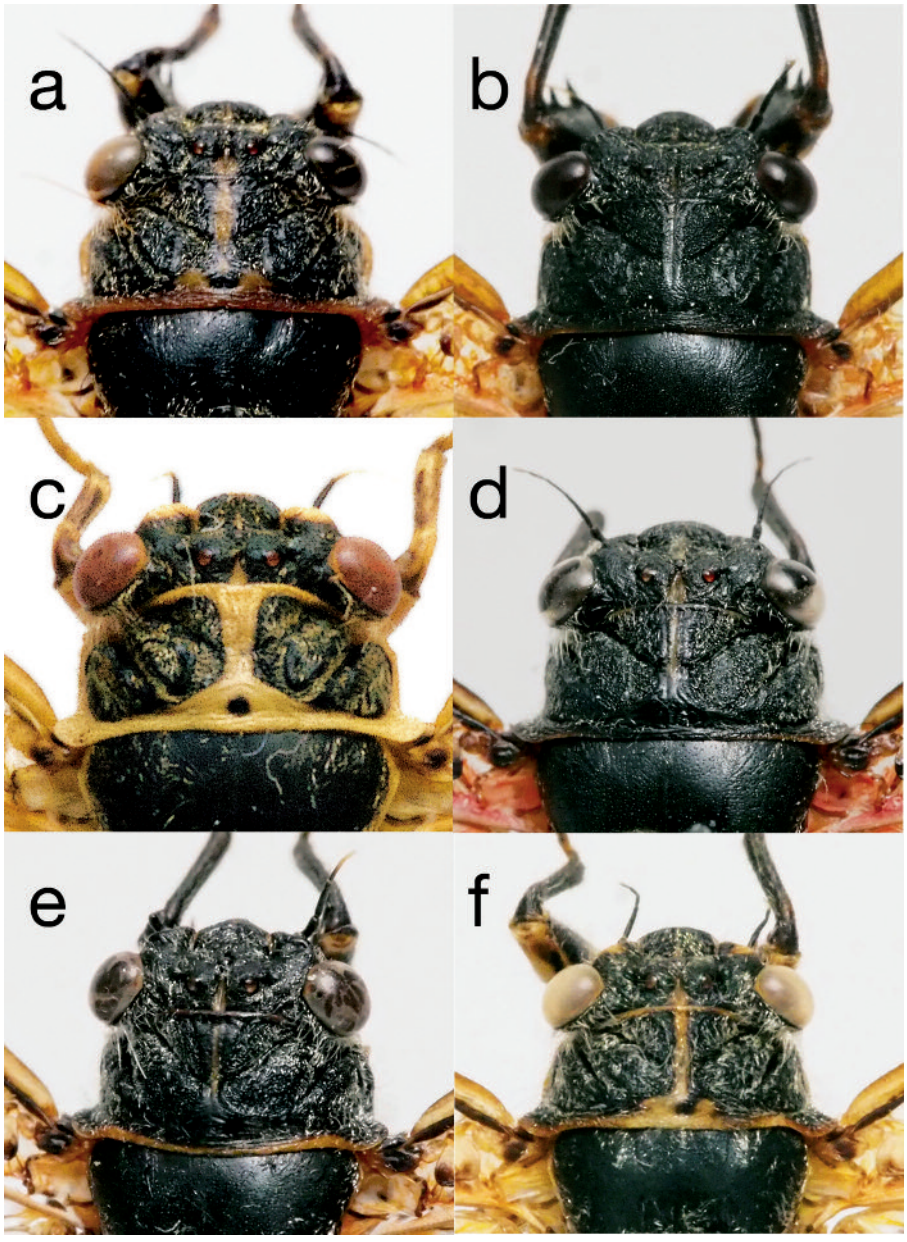

Fig. 26: Details of thoracal morphology. Upper row from left to right: a - *Mezammira tibialis* comb. nova, b - *M. goumenissa* comb. nova; middle row: c - *M. flaveola* comb. nova, d - *M. carayoni* comb. nova; lower row: e - *M. sakisi* sp. nova, f - *M. filoti* sp. nova - the connection of the black spot to the dark fields is only in this specimen present just on the right side.

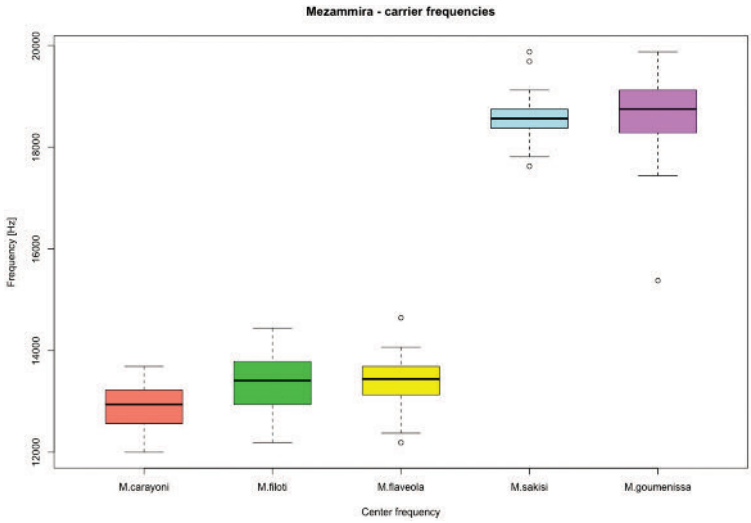

Fig. 27: Boxplot of center frequencies of the songs of different *Mezammira* species from Greece (except *M. tibialis* comb. nova).

and L echemes as compared to most of other species are characteristic (Gogala et al., 1996; Sueur & Puissant, 2000), and in *M. goumenissa* comb. nova in addition to the very fast repetition of short echemes also long (0.5 s) and very long echemes (up to 15 s) periodically appear in the song (Gogala et al., 2013). In all species the song may take many minutes without interruption. Carrier frequencies of the timbal sounds of all these species are high, from 10 to 24 kHz but with species specific differences.

Differences:

Differences between the Greek *Mezammira* species enable us to discriminate between these taxa by morphological and/or acoustic traits (Tables 2 and 3, Key).

Geographic distribution and acoustic parameters

Species *M. filoti* sp. nova and *M. carayoni* comb. nova are present only on the islands of Naxos and Crete respectively (Fig. 29). We do not exclude the possibility, that *M. filoti* sp. nova could in the future be found also on some other islands of the Cyclades. However, we did not find it on the island of Andros, which we investigated before (Gogala & Trilar, 2014). Regardless, it is clear that these two species are not sympatric with any other *Mezammira* species. Therefore, there is no selective pressure to prevent cross mating with closely related species, and the calling songs of the species can be and actually are very similar to the song of the in Greece widely distributed *M. flaveola* comb. nova (Figs. 15, 23 above).

The next species, which is present only very locally on the northern Peloponnese, is *M. goumenissa* comb. nova. This species is sympatric and even syntopic with *M. flaveola* comb. nova, but the song patterns and carrier frequency parameters are clearly different, probably at least partly preventing cross mating in the field. In

addition both species are phenologically slightly shifted (about 14 days) but still overlapping in imaginal occurence. Cicadas of *M. goumenissa* comb. nova are usually sitting on shrubs or small trees, and *M. flaveola* on the grass and herbaceous plants close to the ground.

A similar situation is also found with *M. sakisi* sp. nova, which also comes in contact with populations of *M. flaveola* comb. nova in Peloponnese. Song patterns of both species are similar with three phrases, the first one, A, comprised of repeating short echemes with similar duration (MMM), the second one, B, with long echemes and short echemes inbetween (LSSLSS...) and the third one, C, with interchanging sequences of one long and one or two shorter echemes (LMLM or LMMLMM...). One difference between the calling songs of both species is in the second phrase, where in the song of *M. sakisi* sp. nova the intervals between long echemes are filled usually with three short echemes (LSSSLSSS...) (Fig. 22 above), while the song of *M. flaveola* comb. nova in most cases has two short echemes (LSSLSS...) (Fig. 23 above). This and some other small quantitative differences could possibly not be enough to prevent cross mating, but there is another important difference between songs of both species. The carrier frequency of the song in *M. sakisi* sp. nova is, like in *M. goumenissa* comb. nova, much higher than in *M. flaveola* comb. nova (Figs. 22, 23, 27, 28).

However, carrier frequencies of the songs in the three allopatric species are lower and very similar (Table 3, Figs. 15, 23, 27, 28). Carrier frequency values for *M. tibialis* are inbetween both groups (Fig. 28). We measured also 5% and 95% frequency limits to get the values for the frequency range that animals use for communication. Using the mathematical relation between body size and carrier frequency developed by Bennet-Clark & Young (1994) we can see that the central carrier frequencies of three allopatric species fit very well with the general rule and the resonance properties of their body size. In contrast to this, the carrier frequencies of both species sympatric with *M. flaveola* comb. nova are much higher than expected, derived from their body size (Fig. 28).

We found *M. sakisi* sp. nova in Eastern Peloponnese, where we succeeded to collect 15 specimens, 12 males and 3 females.

On the slopes of Mt. Taigetos we recorded a very similar song with comparable high frequency range (Table 3) and three phrases A, B and C, but collected only 2 males of which one shows quite aberrant habitus, similar in some traits to *M. flaveola* comb. nova. Therefore we are not absolutely sure that we are dealing with the same taxon there (Fig. 29: *M.* cf. *sakisi*). It is also possible that this specimen exchanged some genes with the sympatric species and could thus be the result of introgression or hybridization between two lineages. Therefore we selected for analysis and description of the new species only specimens and recordings from the Eastern Peloponnese.

Further investigations of Mt. Taigetos population are needed. However, we should mention that we detected and recognised the characteristic song of *M.* cf. *sakisi* and its differences as compared to *M. flaveola* comb. nova for the first time on the slopes of Taigetos in the Rintomo gorge and near the village Dendra.

It should be mentioned, that in the morphological traits of *M. filoti* sp. nova we found high variability (e.g. number of apical cells, the length ratio between ulnar and apical cell, ratio of the length of the fused veins MCuA compared to the length of arculus). In the Fig. 26f we can see that in one specimen the connection between the black spot on pronotal collar and the lateral field exists only on one side. Could this variability be explained by inbreeding in a small population ocurring in an area of about 1.3 x 0.6 km, where the species is distributed on the island of Naxos? However, the acoustic traits, usually representing the specific-mate recognition system in cicadas (SMRS; e.g. Paterson, 1985; Den Hollander, 1995; Villet, 1995), appear to be more stable than morphological traits.

Are almost identical song patterns and carrier frequencies in three alopatric species *M. flaveola* comb. nova*, M. filoti* sp. nova and *M. carayoni* comb. nova evidence for a common ancestor with such characteristics?

The rhythmic pattern in *M. sakisi* sp. nova and the still enigmatic population on Mt. Taigetos is not very different either. However, the song pattern of *M. goumenissa* comb. nova differs substantially from all other species discussed in this paper (Gogala et al., 2013; Fig. 30) as well as from *M. tibialis* comb. nova (Gogala et al., 1996; Sueur & Puissant, 2000). But even in these species we find characteristic fast repetition of short echemes as stated earlier. We found substantial differences between *M. goumenissa*

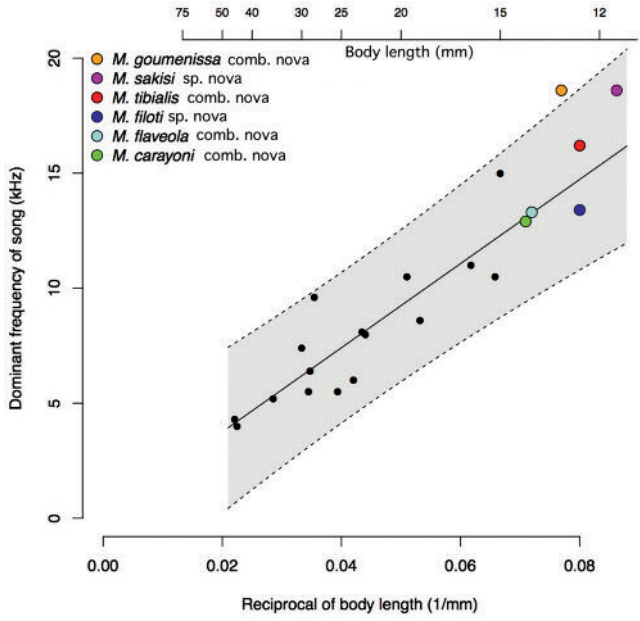

Fig. 28: Graph of dominant frequency in the song vs. the reciprocal of body length. Regression line ($r^2 = 0.764$) and shaded 95% prediction band are calculated from the data of Bennet-Clark & Young, (1994) (black points). For reference the body length scale is also shown.

Fig. 29: Map with localities of Greek *Mezammira* species (see legend).

comb. nova and *M. tibialis* comb. nova on one hand compared to the rest of other *Mezammira* species also in morphology, e.g. genitalia with long pseudoparameres in contrast to short ones in the other species under discussion (Figs. 27c, 27d).

At the end and as it was published for the species of the genus *Cicadetta* (Hertach et al., 2016), we should mention that in the future many questions about the taxonomy, relation and phylogeny of *Mezammira* species studied could be clarified with more comprehensive analyses of acoustic recordings and molecular analyses.

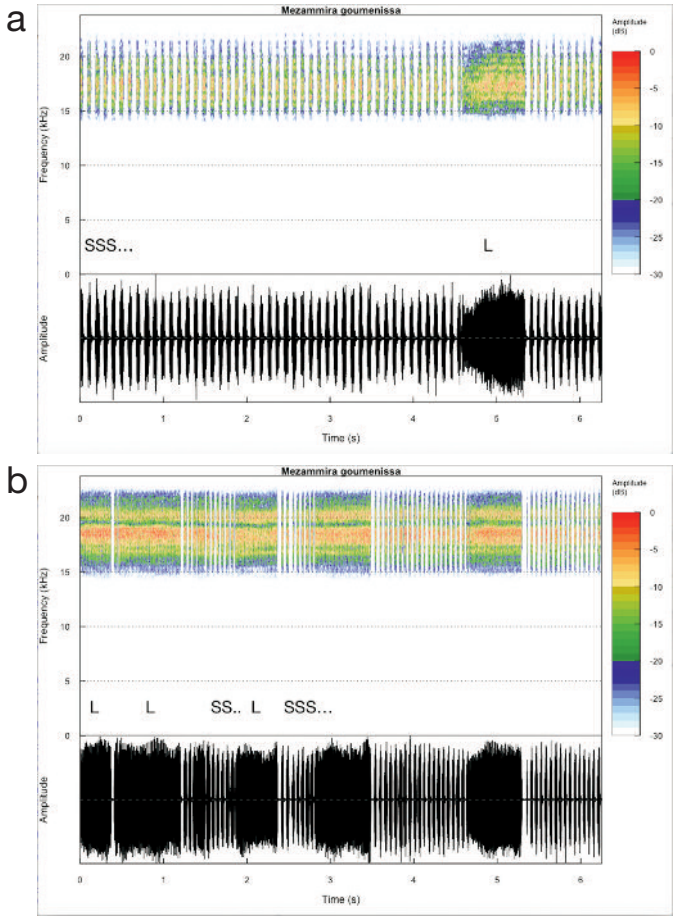

Fig. 30: *Mezammira goumenissa* comb. nova, part with long sequences of short and one long echeme (a) and part with many longer echemes and sequences of short ones with very high repetition rate (b). Song selections of similar duration as in Figs. 15, 22, 23.

We tried to show the differences between males of all taxa of the genus *Mezammira*, present in Greece, in the morphological and acoustic keys.

Morphological key

Common traits:
Body size 11-16 mm
Sternite VIII as long or slightly shorter than sternite VII
Pygofer basal lobe in ventral view showing inner tooth present
Claspers hooked anterolaterad

Median lobe of uncus small, not dominant, semicircular
(Forewing usually with 8 apical cells, hindwing usually with 5)

Differences

(1a) Body coloration yellow with black markings, pronotal collar with black medial spot, mostly not connected to the black lateral fields on pronotum → *Mezammira flaveola* comb. nova

(1b) Body coloration dark (black or brown) with yellow markings. If the central spot on the pronotal collar present, it is connected to the lateral black fields on pronotum → 2

(2a) Pseudoparameres long, flat, divergent, much longer than the uncus → 3

(2b) Pseudoparameres short, flat, hardly visible, not extending beyond the tip of uncus, → 4

(3a) Forewings with 8, hindwings usually with 5 apical cells. Pronotum with yellow dorsal midline, reddish basis of wings and redbrown hind part of abdominal tergites. Widely distributed species in southern Europe → *Mezammira tibialis* comb. nova

(3b) Forewings with 8, hindwings with 6 apical cells. Body coloration black with lighter markings, wing veins yellow. Inhabiting Northern Peloponnese → *Mezammira goumenissa* comb. nova

(4a) Prevailing body colour black with brown or redbrown markings. Apical cells on forewings 8, on hindwings 6. Proximal parts of wings red. Endemic species of Crete → *Mezammira carayoni* comb. nova

(4b) Prevailing body colour black or brown, with yellow and brown markings. Forewings with 7 or 8 and hindwings mostly with 5 apical cells → 5

(5a) Pronotal collar black, also the rest of pronotum with exception of yellow median line in the front part of pronotum. Opercula dark. The eyes in living animals black, the ratio of ulnar to apical cell in forewings 1.4. Small animals, species distributed in Eastern part of Peloponnese → *Mezammira sakisi* sp. nova

(5b) Pronotal collar with dark central spot connected to lateral black fields on pronotum, median line on pronotum broad. Opercula pale yellow → 6

(6a) Eyes in living animals red, abdominal terga with posterior part yellow and red. 7 or 8 apical cells on forewings, 5 on hind wings. Endemic species of the island Naxos → *Mezammira filoti* sp. nova

(6b) Eyes in living animals brown, species distributed on the western slope of Mt. Taigetos → a yet undefined taxon (*M.* cf. *sakisi*) with very similar acoustic characteristics as close related *M. sakisi* sp. nova

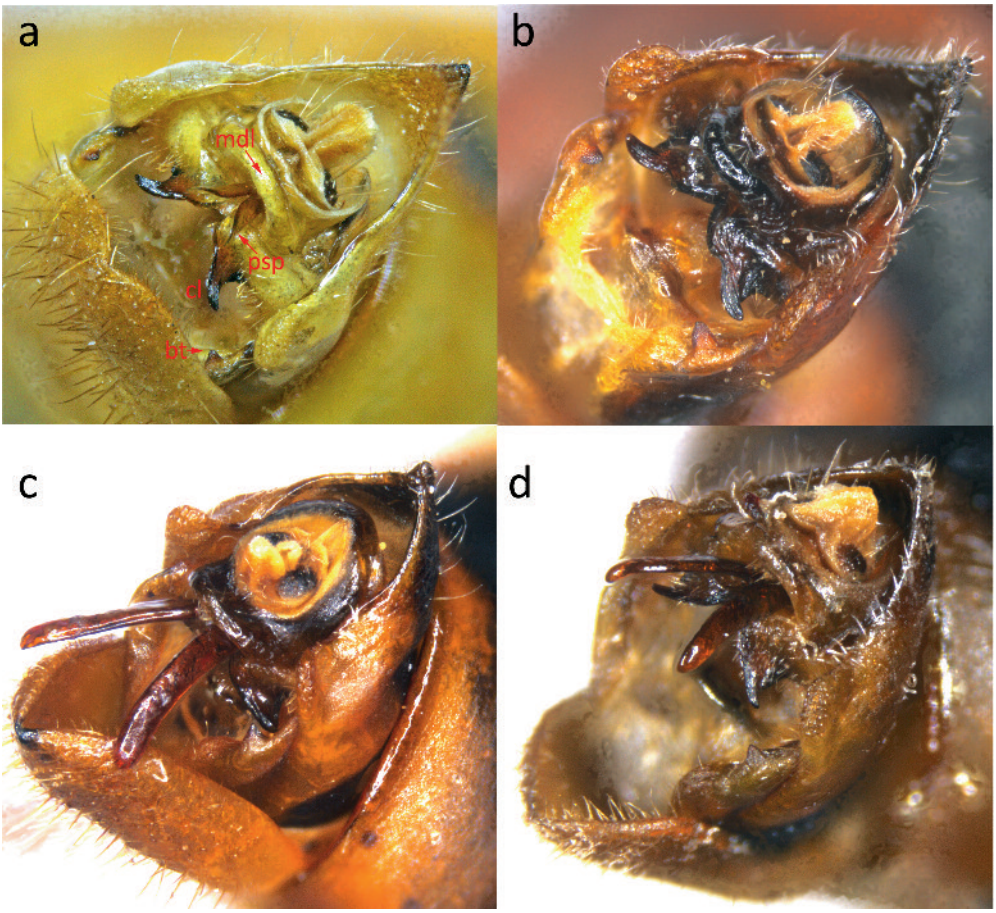

Fig. 31: Genitalia of: a - *Mezammira flaveola* comb. nova; b - *M. carayoni* comb. nova; c - *M. tibialis* comb. nova; d - *M. goumenissa* comb. nova Only in the last two species pseudoparameres are long and clearly visible (multifocus photography). mdl - median lobe of uncus, psp - pseudoparamere, cl - clasper, bt - inner tooth on the basal lobe of pygofer.

Acoustic key:

Common traits:

High pitched sound 10-24 kHz

Fast repetition of short echemes (repetition rate 5-20 Hz) prevailing in the song

Rhythmic sound with more than one type of echemes with different duration

Calling song organized in phrases (typical sequences of short and long echemes)

Phrases exchanging without interruption

No important amplitude or frequency modulation of echemes
Duration of longest echemes <150 ms (with exception of *M. tibialis* comb. nova and *M. goumenissa* comb. nova)
Duration of the interval between successive echemes <200 ms

Differences

(1a) Song comprising fast sequences of short echemes and long echemes, duration of longest ones exceeding 200 ms → 2
(1b) Song comprising sequences of short and longer echemes, duration of longest ones not exceeding 150 ms → 3

(2a) Two different phrases, phrase A with simple repetition of short echemes (~50 ms), phrase B comprising sequences of short echemes and single long echemes (~300 ms). Long echemes never longer than 0.5 s → *Mezammira tibialis* comb. nova
(2b) Duration of short echemes 26±7 ms, long echemes about 0.5 s and of very long echemes up to 15 s, carrier frequency 15-22 kHz → *Mezammira goumenissa* comb. nova

(3a) In addition to the phrase A (MMM) and phrase B (LSS(S)LSS) long sequences (many seconds) of the phrase C (LSLS) present → 4
(3b) Only phrase A (MMM) and B (LSS(S)LSS) present → 5

(4a) Carrier frequency 10-15 kHz → *Mezammira flaveola* comb. nova
(4b) Carrier frequency 15-22 kHz → *Mezammira sakisi* sp. nova and/or *M.* cf. *sakisi* from Taigetos.

(5a) Long echeme duration does not exceeding 50 ms. Endemic species of the island Crete → *Mezammira carayoni* comb. nova
(5b) Long echemes duration longer than 50 ms. Endemic species of the island Naxos → *Mezammira filoti* sp. nova

Acknowledgements

This paper is dedicated to the late Prof. Dr. Sakis Drosopoulos who supported and shared our research on cicadas in Greece during many years. We are also very thankful to his life companion Hanneke Drosopoulou for her help, great hospitality and for improving our English text. For discussions and suggestions about the nomenclature rules concerning the genus *Mezammira* we are indebted to Allen F. Sanborn (Barry University, USA). He also improved substantially our manuscript as a reviewer. For a study of body length and carrier frequency we are thankful to Andrej Blejec (National Institute of Biology, Ljubljana). We appreciate also additional distribution data provided by Wolfgang Schedl (Innsbruck). Vladimir Gnezdilov (St. Petersburg) helped us with photographs of type material from the Zoological Museum. Jocelyne Guglielmi

from the library of the MNHN kindly provided a copy of a rare plate XXXI in the book of Brullé (1833) from the library of the Entomological Society of France (SEF). We thank also Gernot Kunz who photographed this plate, Jérôme Sueur and Laurent Fauvre (MNHN, Paris) for the pictures of the types of *Tettigetta acuta* (Dlabola, 1961). For the detailed photo of *Mezammira flaveola* from the better version of Fig. 13 on the plate XXXI used in our Fig. 3 we are indebted to the NEV Library, Naturalis Biodiversity Center and the librarian Godard Tweehuysen. Our field research was supported by the Slovenian Museum of Natural History and Slovenian Academy of Sciences and Arts. The research of the last author (TT) was part of the programme "Communities, relations and communications in the ecosystems" (No. P1-0255) financed by the Slovenian Research Agency. We are grateful to Dr. Matjaž Kuntner, the Head, and to Dr. Matjaž Gregorič, researcher of the Evolutionary Zoological lab of the Jovan Hadži Biological Institute, Scientific Research Centre of the Slovenian Academy of Sciences and Arts (ZRC SAZU), Ljubljana, Slovenia for the possibility to use their Leitz multifocal system for some photographs. We are also grateful to Dr. Andrej Gogala (Slovenian Museum of Natural History, Ljubljana), who did the preparations of the material. We would like to thank Katarina Prosenc Trilar, who accompanied us in the field and helped us with logistics.

References

Amyot C.J.B., 1847. Entomologie française. Rhynchotes. Ordre deuxième. Homoptères. Homoptera. Latreille. – *Annales de la Société Entomologique de France* **5**: 143–238.

Amyot C.J.B., 1848. *Entomologie française. Rhynchotes. Ordre deuxième. Homoptères. Homoptera. Latreille*. – Reprint of Amyot 1847 with different pages, 1–504.

Bennet-Clark H.C., Young D., 1994. The scaling of song frequency in cicadas. – *Journal of Experimental Biology* **191**: 291-294.

Boulard M., 1982a. Taxa nouveau pour la faune des Cigales de France [Hom.]. – *Bulletin de la Société entomologique de France* **87**(1/2): 49–50.

Boulard M., 1982b. Sur deux cigales nouvelles du bassin méditerranéen. – *Nouvelle revue d'Entomologie* **12**(1) : 101–105.

Boulard M., 1995. Postures de cymbalisation, cymbalisations et cartes d'identité acoustique des cigales. 1.- Généralités et espèces méditerranéenes (Homoptera Cicadoidea). – *EPHE Biol. Evol. Insectes* **7/8**: 1-72.

Boulard M., Mondon B., 1996. *Vies et mémoires de Cigales*. – Equinoxe, Barbentane, 160 pp.

Brullé G.A., 1833. 1.re Partie. Zoologie. Deuxième Section. Des animaux articulés. – In: Bory de Saint-Vincent J. B. G. M. 1832– 1836 – Expédition scientifique de Morée. Section des sciences physiques. III. – Levrault F. L., Paris, Strasbourg (France), 400 pp + pl. i–lxxxiii.

Buckton G.B., 1889a. Notes on the classification of Cicadae. – *Entomologist* **22**: 269-270.

Davis W.T., 1920. North American Cicadas belonging to the genera *Platypedia* and *Melampsalta*. – *Journal of the New-York entomological Society* **28**(2): 95-135.

Den Hollander J., 1995. Acoustic signals as specific mate recognition signals in leafhoppers (Cicadellidae) and planthoppers (Delphacidae) (Homoptera: Auchenorrhyncha). Speciation and the recognition concept, theory and application. – Baltimore: Johns Hopkins University Press, pp. 440–463.

Distant W.L., 1906. *A synonymic catalogue of Homoptera. Part. I. Cicadidae*. – British Museum, London, 207 pp.

Dlabola J., 1959. Unika und Typen in der Zikadensammlung G. Horváths (Homoptera, Auchenorrhyncha). – *Acta Zoologica Hungarica* **5**(1/2): 33–39.

Dlabola J., 1961. Die Zikaden von Zentralasiën, Dagestan und Transkaukasien. – *Acta Entomologica Musei Nationalis Pragae* **34**: 241–358.

Dlabola J., 1963. Typen und wenig bekannte Arten aus der Sammlung H. Haupt mit Beschreibungen einiger Zikadenarten aus Sibirien (Homoptera). – *Acta Entomologica Musei Nationalis Pragae* **35**: 313–331.

Duffels J.P., Van der Laan P.A., 1985. *Catalogue of the Cicadoidea (Homoptera, Auchenorhyncha) 1956–1980*. –W. Junk, Dordrecht, i-xiv + 414 pp.

Emelyanov A.F., 1996. Two new Cicadidae species similar to *Cicadetta tibialis* (Homoptera, Cicadidae). – *Zoologichesky Zhurnal* **75**: 1897–1900. [In Russian, English summary]

Eversmann E., 1859. Cicadae Volgo-Uralenses, oder die in den Gegenden östlich von der Wolga und dem Uralfluss, südlich bis zum Aralsee und dem Sir-Darja bis jetzt beobachteten Singzirpen. *Bulletin de la Société Impériale des naturalistes de Moscou* 32:147–151.

Fahringer J., 1922. Eine Rhynchotenausbeute aus des Turkei, Kleinasien und den benachbarten Gebieten. – *Konowia* **1**: 296–307.

Fieber F.X., 1872. *Katalog der europäischen Cicadinen, nach Originalien mit Benützung der neuesten Literatur*. – Carl Gerold's Sohn, Wien, i-iv + 1-19.

Fieber F.X., 1876. Les Cicadines d'Europe d'après les originaux et les publications les plus récentes. – *Revue et Magazine de Zoologie Pure et Appliquée* **4**: 11–268. [Translation from German by Rieber F.].

Gnezdilov V.M., Bourgoin T., 2017. The mythic species *Issus analis* Brullé, 1833 (Hemiptera, Fulgoroidea, Issidae): still an enigmatic taxon. *Zootaxa* 4; 4216(2): zootaxa.4216.2.6. doi: 10.11646/zootaxa.4216.2.6.

Gogala M., 2013.- *On the Trail of Mountain Cicadas*. – Slovenian Academy of Sciences and Arts, Ljubljana, and Royal Entomological Society, London. 173 pp.

Gogala M., Drosopoulos S., 2006. Song of *Cicadetta flaveola* Brullé (Auchenorrhyncha: Cicadoidea: Tibicinidae) from Greece. – *Russian Entomological Journal* **15**(3): 275–278.

Gogala M., Trilar T., 2014. Distribution of endemic cicadas (Hemiptera: Cicadidae) on Evia and adjacent islands in Greece. – *Acta entomologica slovenica* **22**(1): 45-58.

Gogala M., Drosopoulos S., Trilar T., 2012. *Cicadivetta goumenissa,* a new cicada species from Peloponesos, Greece (Hemiptera: Cicadidae). – *Acta entomologica slovenica* **20**(1): 5–16.

Gogala M., Drosopoulos S., Trilar T., 2013. New distributional and bioacoustic data about *Cicadivetta goumenissa* from Peloponnese, Greece (Hemiptera, Cicadidae). In: Popov A, Grozeva S, Simov N, Tasheva E (Eds): Advances in Hemipterology. – *ZooKeys* **319**: 83–91. doi: 10.3897/zookeys.319.4452.

Gogala M., Popov A.V., Ribarič D., 1996. Bioacoustics of singing cicadas of the western Palaearctic: *Cicadetta tibialis* (Panzer) (Cicadoidea: Tibicinidea). – *Acta entomologica slovenica* **4**(2): 45-62.

Gogala M., Trilar T., Drosopoulos S., 2011. Two new species and a new genus of Cicadettini (Hemiptera, Cicadidae) from the Greek island of Evia. – *Deutsche Entomologische Zeitschrift* **58**(1): 105–117.

Gomez-Menor Ortega J., 1957. Monographia de Cicadidos (Homoptera) de España. – *Memorias de la Real Academia de Ciencias exactas, fisicas y naturales de Madrid. Serie de Ciencias naturales* **19**: 89 pp.

Hagen H.A., 1856. Die Sing-Cicaden Europa's. – *Stettiner Entomologische Zeitung* **17**: 66–91.

Herrich-Schäffer G.A.W., 1835. *Nomenclator entomologicus. Verzeichnis der europäischen lnsecten; zur Erleichterung des Tauschverkehrs mit Preisen versehen. Erstes Heft. Lepidoptera und Hemiptera, leztere synoptisch bearbeitet und mit vollständiger Synonymie*. – F. Pustet, Regensburg, i-iv + 116 pp.

Hertach T., Puissant S., Gogala M., Trilar T., Hagmann R., Baur H., Kunz G., Wade E.J., Loader S.P., Simon C., Nagel P., 2016. Complex within a complex: integrative taxonomy reveals hidden diversity in *Cicadetta brevipennis* (Hemiptera: Cicadidae) and unexpected relationships with a song divergent relative. – *PLoS ONE* **11**(11): 1–41.

Hoch H., Asche M., Claridge M.F., 2015. Remembering Prof. Athanasios (Sakis) Drosopoulos (1944–2014) – biosystematist, entomologist, colleague and friend. – *Entomologica austriaca* **22**: 149-171.

Horváth G., 1901. Hémiptères du voyage de M. Martinez Escalera dans l'Asie-Mineure. – *Természetrajzi Füzetek* **24**: 469–485.

Horváth G., 1911. Hemiptera nova vel minus cognita e regione palaearctica. II. – *Annales Musei Nationalis Hungarici* **9**: 573–610.

Horváth G., 1912. Miscellanea Hemipterologica. X. Cicadidarum genera palaearctica. – *Annales Musei Nationalis Hungarici* **10**: 602–606.

ICZN, 1999. *International Code of Zoological Nomenclature. Fourth Edition*. – International Trust for Zoological Nomenclature, London, xxix + 306 pp.

Kemal M., Koçak A.-Ö., 2010. *Cicadidae* of Turkey and some ecological notes on *Tibicina serhadensis* Koçak & Kemal from Van Province (East Turkey) (Homoptera). – *Tesa News* **55**, 1–19.

Kirkaldy G.W., 1908. Bibliographical and nomenclatorial notes on the Hemiptera, No. 7. – *Entomologist* **41**: 12–15.

Kirkaldy G.W., 1909. Hemiptera, old and new, No. 2. – *The Canadian Entomologist* **41**: 388–392.

Kolenati F.A., 1857. Homoptera Latreille. Leach. Gulaerostria Zetterstedt. Meletemata entomologica. – *Bulletin de la Société Impériale de Moscou* **30**: 399–429.

Lodos N., Kalkandelen A., 1981. Preliminary list of Auchenorrhyncha with notes on distribution and importance of species in Turkey. V. Families Flatidae, Ricaniidae and Cicadidae. – *Türkiye Bitki koruma Dergisi* **5**(2): 67–82.

Metcalf Z.P., 1963. *Cicadoidea, Part 2 Tibicinidae*. – General Catalogue of the Homoptera, **8**(2): vi + 492 pp.

Moulds M., 2005. An appraisal of the higher classification of cicadas (Hemiptera: Cicadoidea) with special reference to the Australian fauna. – *Records of the Australian Museum* **57**(3): 375-446.

Moulds M., 2012. A review of the genera of Australian cicadas (Hemiptera: Cicadoidea). – *Zootaxa* **3287**: 1–262.

Nast J., 1972. Palearctic Auchenorrhyncha (Homoptera), an annotated check list. – *Polish Scientific Publications, Warsaw*, 550 pp.

Neave S.A., 1940. *Nomenclator Zoologicus. A list of the names of genera and subgenera in zoology from the tenth editions of Linnaeus 1758 to the end of 1935*. – The Zoological Society of London **3**: i–ii, 1–1065.

Opinion 2165, 2006. Opinion 2165 (Case 3327). Amyot, Méthode mononymique (1845–1847): correction to Opinion 686. – *Bulletin of Zoological Nomenclature* **63**(4): 284–285.

Oshanin V.T., 1906. Verzeichnis der palaearktischen Hemipteren mit besonderer Berücksichtigung ihrer Verteilung im Russischen Reiche. II. Band. Homoptera. I. Lieferung. – *Annals of Museum of Zoology of Academy of Science of Saint Petersburg* **11**: i–xvi, 1–192.

Oshanin V.T., 1908. Verzeichnis der palaearktischen Hemipteren mit besonderer Berücksichtigung ihrer Verteilung im Russischen Reiche. II. Band. Homoptera. III. Lieferung. – *Annals of Museum of Zoology of Academy of Science of Saint Petersburg* **13**: 385–492.

Oshanin V.T., 1912. *Katalog der paläarktischen Hemipteren (Heteroptera, Homoptera-Auchenorhyncha und Psylloideae)*. – R. Friedländer & Sohn, Berlin, pp. i–xvi, 1–187.

Panzer G.W.F., 1798. Tettigonia tibialis. – *Faunae Insectorum Germanicae initia: oder Deutschlands Insecten* 59: 5.

Paterson H.E.H., 1985. *The recognition concept of species. Species and Speciation*. –Transvaal Museum Monograph., Pretoria, pp. 21–29.

Popov A.V., 1997. Acoustic signals of three morphologically similar species of singing cicadas (Homoptera, Cicadidae). – *Entomologicheskoe Obozrenie* **76**(1): 3-15, 232. [In Russian]

Puissant S., 2006. *Contribution à la connaissance des Cigales de France: géonémie et écologie des populations (Hemiptera, Cicadidae)*. – ASCETE, Bédeilhac et Aynat, 193 pp.

Puissant S., Sueur J., 2010. A hotspot for Mediterranean cicadas (Insecta: Hemiptera: Cicadidae): new genera, species and songs from southern Spain. – *Systematics and Biodiversity* **8**(4): 555–574. doi: 10.1080/14772000.2010.532832.

Puton A., 1875. *Homoptera. Am. Serv. (Gulaerostria. Zett. Fieb.) Sect. I. Auchenorhyncha. Dumér. (Cicadina. Burm.)*. – Catalogue des Hémiptères (Hétéroptères, Cicadines et Psyllides) d'Europe et du bassin de la Méditerranée. 2e Ed. **1875**: 1–165.

R Core Team, 2015. R: A language and environment for statistical computing. – R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Sanborn A.F., 2014. *Catalogue of the Cicadoidea (Hemiptera: Auchenorrhyncha)*. – Elsevier Academic Press, Amsterdam, Boston, Heidelberg, London, New-York, Oxford, Paris, San-Diego, San-Fransico, Singapore, Sydney, Tokyo, 1001 pp.

Schedl W., 1999. Contribution to the singing cicadas of Israel and adjacent countries (Homoptera, Auchenorrhyncha: Cicadidae et Tibicinidae). – *Linzer Biologische Beiträge* **31**(2): 823–837.

Schedl W., 2001. Eine neue Singzikade aus der Türkei, *Tettigetta turcica* nova spec. (Cicadoidea, Tibicinidae). – *Linzer Biologische Beiträge* **33**: 1287–1290.

Schneider A., 2003–2016. GPS Visualizer. – http://www.gpsvisualizer.com [1.10.2016].

Schumacher F., 1922. Nomenklatorische Notizen zu paläarktischen Cicadiden. – *Deutsche entomologische Zeitschrift* **1922**: 210–213.

Schumacher F., 1923. *Hemiptera-Homoptera* der 2. botan. Forschungsreise von A. Kneucker auf der Sinai-Halbinsel. – *Deutsche entomologische Zeitschrift* **1923**: 236–238.

Stål C., 1866. Hemiptera Homoptera Latr. – *Hemiptera Africana* **4**: 1–276.

Sueur J., Aubin T., Simonis C., 2008. Seewave: a free modular tool for sound analysis and synthesis. – *Bioacoustics* **18**: 213-226.

Sueur J., Puissant S., 2000. Emissions sonores d'une population française de *Cicadivetta tibialis* (Panzer, 1798) (Homoptera, Cicadoidea, Cicadidae). – *Annales de la Société entomologique de France* **36**: 261–268.

Sueur J., Puissant S., Simoes P.-C., Seabra S., Boulard M., Quartau J.-A., 2004. Cicadas from Portugal: revised list of species with eco-ethological data (Hemiptera: Cicadidae). – *Insect Systematics and Evolution* **35**(2): 177–187.

Szilády Z., 1870. Magyarországy rovargyüjtésem jegyzéke. – *Rovartani Lapok* **7**: 113–121.

Trilar T., Gogala M., 2008. New data on singing cicadas (Hemiptera: Cicadidae) of Romania. – *Entomologica Romanica* **13**: 29–33.

Trilar T., Gogala M., 2010. *Tettigetta carayoni* Boulard (Hemiptera: Cicadidae) from Crete, faunistic data and first description of its song. – *Acta entomologica slovenica* **18**(1): 5–18.

Trilar T., Gogala M., Popa V., 2006. Contribution to the knowledge of the singing cicadas (Auchenorrhyncha: Cicadoidea) of Romania. – *Acta entomologica slovenica* **14**(2): 175–182.

Uhler P.-R., 1888. Preliminary survey of the Cicadaea of the United States, Antilles and Mexico. – *Entomologica Americana* **4**: 81–85.

Villet M., 1995. Intraspecific variability in SMRS signal: some causes and implications in acoustic signalling systems. Speciation and the recognition concept, theory and application. – Baltimore: Johns Hopkins University Press; pp. 422–439.

Walker F., 1850. *List of the specimens of Homopterous Insects in the collection of the British Museum*. *Part. I.* – British Museum (Natural History) London, 260 pp.

Waltl Z., 1837. Beschreibung zweier neuer Gattungen aus Andalusien. – *Isis* **4**: 288.

Received / Prejeto: 2. 1. 2017

Table 1: *Mezammira* of Greece (based on bioacoustics)

***Mezammira carayoni* Boulard, 1982**

GR: island Crete: Chania: Kolymbari; 35°32.048'N, 23°46.753'E; 30 m; 19.5.2013; collected 1♂; J.-C.Streito.
GR: island Crete: Lasithi: Farsaro; 35°11.393'N, 25°29.832'E: 780 m; 17.6.2005; collected 3♂ 1♀; S.Peslier.
GR: island Crete: Lasithi: Aghios Nikolaos, Kritsa, Lato; 35°10'23.3"N, 25°39'13.9"E; 313 m; 2.6.2006; song heard; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Lasithi: Aghios Nikolaos, Kritsa, Panaghia Kera; 35°09'23.9"N, 25°39'19.2"E; 225 m; 2.6.2006; song heard; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Lasithi: Aghios Nikolaos, Kritsa, pod vrhom Lato; 35°10'10.8"N, 25°39'21.7"E; 315 m; 31.5.2006; recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Lasithi: Aghios Nikolaos, Ellounda; 35°15'27.0"N, 25°43'37.8"E; 24 m; 31.5.2006; song heard; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Lasithi: Aghios Nikolaos, Ellounda; 35°15'27.0"N, 25°43'37.8"E; 24 m; 1.6.2006; song heard; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Lasithi: Katharo Plateau, Katharo Tsivi; 35°10'27.1"N, 25°32'49.9"E; 1135 m; 1.6.2006; collected, recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Lasithi: Katharo Plateau, Kopraki; 35°09'50.0"N, 25°32'36.7"E; 1180 m; 1.6.2006; collected, recorded, photographed; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Lasithi: Lasithi Plateau, Aghios Georgios; 35°09'56.4"N, 25°29'30.7"E; 820 m; 1.6.2006; collected, recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Lasithi: Lasithi Plateau, Aghios Haralambos; 35°10'16.0"N, 25°26'20.5"E; 850 m; 1.6.2006; recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Lasithi: Lasithi Plateau, Mesa Lasithi; 35°11'29.8"N, 25°31'31.7"E; 995 m; 1.6.2006; collected; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Lasithi: Lasithi Plateau, Moni Vidianis; 35°11'31.4"N, 25°26'35.3"E; 810 m; 1.6.2006; collected; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Lasithi: Lasithi Plateau, Psychro, in front of the cave Dikteo Andro; 35°09'44.9"N, 25°26'46.8"E; 950 m; 1.6.2006; song heard; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Lasithi:Neapoli, Drasi; 35°13'16.1"N, 25°36'17.3"E; 340 m; 1.6.2006; recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Lasithi:Neapoli, Tzermiadhon; 35°12'22.9"N, 25°31'13.4"E; 920 m; 1.6.2006; recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Adele, Adelianos Kambos, hotel Adele Mare; 35°22'17.7"N, 24°33'04.9"E; 2 m; 28.5.2006; collected; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Adele, Harkia; 35°18'23.5"N, 24°34'47.5"E; 460 m; 27.5.2006; collected, recorded; T.Trilar, K.Prosenc Trilar.

GR: island Crete: Rethymno: Adele, Loutra; 35°21’11.7”N, 24°35’9.84”E; 100 m; 29.5.2006; song heard; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Adele, Mesi; 35°20’16.2”N, 24°34’31.7”E; 210 m; 27.5.2006; collected, recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Adele, Pigi; 35°21’30.4”N, 24°35’57.5”E; 41 m; 29.5.2006; song heard, recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Aghia Fotini, Pantanassa; 35°16’12.9”N, 24°35’08.7”E; 285 m; 28.5.2006; recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Aghia Fotini, Patsos, Kato Hadika; 35°13’47.3”N, 24°33’12.9”E; 655 m; 28.5.2006; recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Anoghia, Tsounia; 35°13’28.4”N, 24°52’52.7”E; 1410 m; 29.5.2006; recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Anoghia, Vathias; 35°16’07.3”N, 24°53’18.9”E; 960 m; 29.5.2006; collected, recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Armeni, Late Minoan Cemetery; 35°19’04.5”N, 24°27’48.1”E; 355 m; 28.5.2006; song heard; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Armeni, Somatas; 35°19’11.5”N, 24°27’50.5”E; 345 m; 28.5.2006; collected, recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Moni Arkadiou; 35°18’23.5”N, 24°37’50.0”E; 495 m; 27.5.2006; song heard; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Perama, Aghia; 35°22’09.2”N, 24°45’44.4”E; 140 m; 29.5.2006; recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Platanias; 35°21’54.0”N, 24°31’02.1”E; 458 m; 30.5.2006; collected; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Spili; 35°13’12.8”N, 24°32’03.0”E; 470 m; 28.5.2006; recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Spili, Kato Hadika; 35°13’46.6”N, 24°32’42.2”E; 655 m; 28.5.2006; collected, recorded; T.Trilar, K.Prosenc Trilar.
GR: island Crete: Rethymno: Nida Plateau, in front of cave Ideo Andro; 35°12’18.5”N, 24°49’57.0”E; 1475 m; 29.5.2006; recorded; T.Trilar, K.Prosenc Trilar.

Mezammira flaveola (Brullé, 1832)

GR: Boeotia: Levadia, Mt. Elikonas, 2 km before Kyriaki; 38°19.713’N, 22°49.843’E; 997 m; 12.7.2010; collected, recorded; M.Gogala, T.Trilar, K.Šporar, S.Drosopoulos.
GR: Boeotia: Levadia, Mt. Elikonas, 6 km before Kyriaki; 38°19.109’N, 22°51.655’E; 885 m; 12.7.2010; song heard; M.Gogala, T.Trilar, K.Šporar, S.Drosopoulos.
GR: East Macedonia and Thrace: Drama: Prosotsani; 41°10.798’N, 23°58.000’E; 160 m;12.8.1979; collected 1 specimen; S.Drosopoulos.
GR: Epirus: Ioannina: Kalpaki, Mesovouni, road to Aghios Minas; 39°57.348’N, 20°38.723’E; 725 m; 17.6.2012; collected 4♂; D.Morin.
GR: Epirus: Ioannina: Konitsa, Kalithea, Ano Klidonia; 39°58’14.4”N, 20°41’29.3”E; 967 m; 2.7.2006; collected, recorded; M.Gogala, T.Trilar, S.Drosopoulos.

GR: Epirus: Thesprotia: Tsamaria Mts., W of Vavouni: 39°46.07'N, 20°22.21'E; 680 m; 14.6.2005; collected; H.Rausch, R.Rausch.
GR: Peloponnese: Arkadia: Chimerini Meligou, Agia; 37°23.309'N, 22°43.169'E; 100 m; 11.6.2005; recorded; M.Gogala, S.Drosopoulos.
GR: Peloponnese: Arkadia: Kastanitsa; 37.25509°N, 22.65053°E; 947 m; 11.6.2005; recorded; M.Gogala, S.Drosopoulos.
GR: Peloponnese: Arkadia: Kollines; 37°17.2'N, 22°21.6'E; 850 m; 17.6.1990; collected; R.Linnavuori.
GR: Peloponnese: Arkadia: Levidi, Kapsia; 37°36'16.2"N, 22°21'52.1"E; 625 m; 28.6.2006; collected, recorded; M.Gogala, T.Trilar, S.Drosopoulos.
GR: Peloponnese: Arkadia: North Kynouria: Kastanitsa; 37.25509°N, 22.65053°E; 947 m; 20.6.2015; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Arkadia: Paradisia; 37°18.885'N, 22°4.705'E; 515 m; 24.6.1996; collected 1♀; J.-M.Maldès.
GR: Peloponnese: Arkadia: South Kynouria: Kosmas (1); 37.09829°N, 22.74114°E; 1136 m; 21.6.2015; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Arkadia: South Kynouria: Kosmas (2); 37.09216°N, 22.74510°E; 1079 m; 21.6.2015; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Arkadia: South Kynouria: Kosmas (3), under the village; 37.09143°N, 22.7631°E; 859 m; 21.6.2015; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Arkadia: South Kynouria: Kosmas pass; 37°05.558'N, 22°44.422'E; 1100 m; 17.6.1996; collected 3♂ 1♀; D.Morin.
GR: Peloponnese: Arkadia: Tyros, Paralia Tirou; 37°14.816'N, 22° 51.670'E; 5 m; 18.6.1996; collected 2♂; D.Morin.
GR: Peloponnese: Arkadia: Vlachokerasia, Alepochori; 37°21.371'N, 22°24.564'E; 890 m; 30.5.1995; collected 1♂; J.-M.Maldès.
GR: Peloponnese: Arkadia: Vlachokerasia, Alepochori; 37°21.371'N, 22°24.564'E; 890 m; 27.6.1996; collected 1♂; D.Morin.
GR: Peloponnese: Corinthia: Archea Feneos, Louzi; 37.88173°N, 22.26854°N; 788 m; 6.6.2016; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar
GR: Peloponnese: Corinthia: Goura (Gkoura); 37.94449°N, 22.34612°N; 917 m; 6.6.2016; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar
GR: Peloponnese: Corinthia: Kastania, hotel Xenia; 37.86808°N, 22.37241°N; 1125 m; 6.6.2016; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar
GR: Peloponnese: Corinthia: Kastania, Mt. Kylini (Mt.Ziria, Mt. Zirea), Oligirtos; 37.87412°N, 22.36350°N; 1154 m; 6.6.2016; collected; M.Gogala, T.Trilar, K.Prosenc Trilar
GR: Peloponnese: Corinthia: Lafka, Mt. Gkrimpini; 37.86056°N, 22.36412°N; 1218 m; 6.6.2016; heard; M.Gogala, T.Trilar, K.Prosenc Trilar
GR: Peloponnese: Corinthia: Mesino, Mosia (Mousi); 37.87792°N, 22.35633°N; 977 m; 6.6.2016; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar
GR: Peloponnese: Corinthia: under the pass Feneos; 37.87804°N, 22.25257°N; 964 m; 6.6.2016; collected (4♂), recorded; M.Gogala, T.Trilar, K.Prosenc Trilar

GR: Peloponnese: GR: Arkadia: Mount Menalo, Menalo Ski Resort; 37°39'22.8"N, 22°15'48.1"E; 1617 m; 28.6.2006; recorded; M.Gogala, T.Trilar, S.Drosopoulos.
GR: Peloponnese: Laconia: Mani Peninsula: Anavriti; 37°01.887'N, 22°22.024'E; 903 m; 28.6.2014; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Mani Peninsula: Anogia; Mt. Taygetos; ???, ???; ??? m; 19.6.1996; collected 1♂; D.Morin.
GR: Peloponnese: Laconia: Mani Peninsula: Perganteika; 37°02.236'N, 22°20.682'E; 1065 m; 28.6.2014; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Mani Peninsula: Taigeti, Korites Vrisi; 37°02.851'N, 22°20.105'E; 1258 m; 28.6.2014; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Mani Peninsula: Taigeti, Vataki Vrisi; 37°02.860'N, 22°20.962'E; 1119 m; 28.6.2014; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Mani Peninsula: Taigeti, Vataki Vrisi; 37°02.860'N, 22°20.962'E; 1119 m; 28.6.2014; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Mani Peninsula: Xirocambi, Krioneri, Mt. Taygetos (1); 36°57.386'N, 22°23.118'E; 1548 m; 1.7.2013; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Mani Peninsula: Xirocambi, Penteli, Katafygio, Mt. Taygetos (1); 36°57.033'N, 22°22.070'E; 1548 m; 1.7.2013; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Mani Peninsula: Xirocambi, Penteli, Katafygio, Mt. Taygetos (2); 36°56.873'N, 22°22.514'E; 1391 m; 3.7.2013; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Mani Peninsula: Xirocambi, Penteli, Mt. Taygetos; 36°56.735'N, 22°22.536'E; 1288 m; 1.7.2013; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Mani Peninsula: Xirocambi, Penteli; 36°55.868'N, 22°23.492'E; 747 m; 1.7.2013; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Mani Peninsula: Xirocambi, Penteli; 36°55.941'N, 22°22.302'E; 1027 m; 1.7.2013; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Messenia: Trifylia, Mt. Egaleo, Palea Vrisi; 37.16625°N, 21.74513°E; 871 m; 28.6.2015; song heard; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Messenia: Trifylia, Mt. Mynthi, deviation to Skliros; 37.45327°N, 21.92164°E; 1130 m; 29.6.2015; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Messenia: Trifylia, Mt. Mynthi, Kryoneri; 37.47512°N, 21.80389°E; 953 m; 28.6.2015; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.

GR: Peloponnese: Messinia: Manesis; 37°5.1'N, 21°53.5'E; 175 m; 17.6.1990; collected; R.Linnavuori.
GR: Peloponnese: Messinia: Mani Peninsula: Agious Vasilios; 37°04.093'N, 22°16.121'E; 1304 m; 24.6.2014; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Messinia: Mani Peninsula: Mt. Kalathi (Sideroportas); 37°02.724'N, 22°14.548'E; 1091 m; 24.6.2014; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Messinia: Platania, Avlonas; 37°22.107'N, 21°47.499'E; 510 m; 7.6.1978, 31.5.1989: 12.7.1979; collected 3 specimens; S.Drosopoulos.
GR: South Aegean: Dodecanese: island Kalymnos; 36°58.901'N, 26°58.879'E; 26.6.1992; collected 1 specimen; S.Drosopoulos.
GR: West Greece: Achaea: Chelmos, Vrachni; 38°2.5'N, 22°8.9'E; 800 m; 6.6.1981; collected; ?.Probst.
GR: West Greece: Achaea: Goumenissa; 38°02.802'N, 22°01.297'E; 720 m; 16.7.2010; collected, recorded, photographed; M.Gogala, T.Trilar, K.Šporar, S.Drosopoulos.
GR: West Greece: Achaea: Goumenissa; 38°02.802'N, 22°01.297'E; 720 m; 10.6.2005; recorded; M.Gogala, S.Drosopoulos.
GR: West Greece: Achaea: Goumenissa; 38°02.802'N, 22°01.297'E; 720 m; 11.6.2005; recorded; M.Gogala, S.Drosopoulos.
GR: West Greece: Achaea: Goumenissa; 38°02'54.7"N, 22°01'47.4"E; 716 m; 28.6.2006; collected, photographed; M.Gogala, T.Trilar, S.Drosopoulos.
GR: West Greece: Achaea: Kalavryta, above the village (ob cest na smučišče, Spartium); 38°01.509'N, 22°07.747'E; 970 m; 10.6.2012; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: West Greece: Achaea: Kalavryta, deviation to Kerpini (and Rogi); 38°03.283'N, 22°08.514'E; 737 m; 9.6.2012; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: West Greece: Achaea: Kalavryta, Kampigadi, Dendra; 38°02.397'N, 21°52.936'E; 674 m; 11.6.2012; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: West Greece: Achaea: Kalavryta, Lagovouni, deviation to Kandalos; 37°57.108'N, 22°02.916'E; 753 m; 10.6.2012; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: West Greece: Achaea: Kalavryta, Manesi; 38°00.834'N, 21°56.694'E; 856 m; 10.6.2012; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: West Greece: Achaea: Kalavryta, Petsaki-Agias Pantelejmon; 38°07'04.1"N, 22°03'19.1"E; 973 m; 28.6.2006; recorded; M.Gogala, T.Trilar, S.Drosopoulos.
GR: West Greece: Achaea: Kleitoria, above the village Armpounas (3); 37.90799°N, 22.19270°N; 1162 m; 5.6.2016; collected (1♂), recorded; M.Gogala, T.Trilar, K.Prosenc Trilar

GR: West Greece: Achaea: Kleitoria, above the village Armpounas (1); 37.92078°N, 22.17276°N; 1018 m; 5.6.2016; collected (2♂), recorded; M.Gogala, T.Trilar, K.Prosenc Trilar
GR: West Greece: Achaea: Klitoria, Priolithos, spomenik padlim; 37°54.968'N, 22°02.988'E; 1019 m; 10.6.2012; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: West Greece: Achaea: Likouria; 37.85739°N, 22.24554°N; 1077 m; 6.6.2016; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar
GR: West Greece: Achaea: Petsaki; 38°5.9'N, 22°2.3'E; 870 m; 15.6.1990; collected; R.Linnavuori.
GR: West Greece: Achaea: Pteri (Fteri); 38°08.848'N, 22°04.272'E; 1135 m; 9.6.2005; recorded; M.Gogala, S.Drosopoulos.
GR: Western Greece: Achaea: Patras, Mt. Panahaiko, Ano Salmeniko (2); 38.23665°N, 21.90267°E; 1003 m; 30.6.2015; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Western Greece: Achaea: Patras, Mt. Panahaiko, Ano Salmeniko (3); 38.22894°N, 21.89293°E; 1305 m; 30.6.2015; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Western Greece: Achaea: Patras, Mt. Panahaiko, Ovriokampos (1); 38.15221°N, 21.90643°E; 1053 m; 1.7.2015; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Western Greece: Achaea: Patras, Mt. Panahaiko, Ovriokampos (2); 38.17998°N, 21.91155°E; 1327 m; 1.7.2015; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Western Greece: Achaea: Patras, Mt. Panahaiko, Ovriokampos (3); 38.16020°N, 21.90433°E; 1221 m; 1.7.2015; collected, song heard; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Western Greece: Achaea: Patras, Mt. Panahaiko, Patero; 38.11822°N, 21.85462°E; 1035 m; 1.7.2015; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Western Greece: Achaea: Patras, Mt. Panahaiko, Rakita; 38.15846°N, 21.94618°E; 1137 m; 1.7.2015; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Western Greece: Achaea: Patras, Mt. Panahaiko, Thomeika; 38.13214°N, 21.89734°E; 1017 m; 1.7.2015; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.

Mezammira goumenissa Gogala, Drosopoulos et Trilar, 2012

GR: West Greece: Achaea: Kalavryta, Lagovouni; 37°57.753'N, 22°03.401'E; 767 m; 10.6.2012; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Western Greece: Achaea: Patras, Mt. Panahaiko, Ano Salmeniko (1); 38.24723°N, 21.90613°E; 744 m; 30.6.2015; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Western Greece: Achaea: Patras, Mt. Panahaiko, Ano Salmeniko (2); 38.23665°N, 21.90267°E; 1003 m; 30.6.2015; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Western Greece: Achaea: Patras, Mt. Panahaiko, Ano Salmeniko (3); 38.22894°N, 21.89293°E; 1305 m; 30.6.2015; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.

GR: West Greece: Achaea: Goumenissa; 38°02.802'N, 22°01.297'E; 720 m; 9.6.2005; recorded; M.Gogala, S.Drosopoulos.
GR: West Greece: Achaea: Goumenissa; 38°02'54.7"N, 22°01'47.4"E; 716 m; 28.6.2006; collected, recorded; M.Gogala, T.Trilar, S.Drosopoulos.
GR: West Greece: Achaea: Goumenissa; 38°03.098'N, 22°01.632'E; 720 m; 9.6.2012; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: West Greece: Achaea: Kalavryta, Kampigadi, Dendra; 38°02.397'N, 21°52.936'E; 674 m; 11.6.2012; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: West Greece: Achaea: Kalavryta, deviation to Kerpini (and Rogi); 38°03.283'N, 22°08.514'E; 737 m; 9.6.2012; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: West Greece: Achaea: Kalavryta, Manesi; 38°00.834'N, 21°56.694'E; 856 m; 10.6.2012; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: West Greece: Achaea: Kalavryta, Skepasto (ob cesti Goumenissa-Kalavryta); 38°01.700'N, 22°02.765'E; 799 m; 9.6.2012; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.

Mezammira sakisi **sp. nova**

GR: Peloponnese: Arkadia: Aghios Andreas; 37°19.634'N, 22°44.279'E; 150 m; 23./24.5.2004; recorded; M.Gogala, S.Drosopoulos.
GR: Peloponnese: Arkadia: South Kynouria: Kounoupia; 37.06039°N, 22.81868°E; 766 m; 22.6.2015; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Arkadia: South Kynouria: deviation to Ieron Naos Agios Dinitrios; 37.13360°N, 22.75941°E; 866 m; 21.6.2015; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Evrotas, Aghios Dimitrios (1); 36.95006°N, 22.83613°E; 531 m; 26.6.2015; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Evrotas, Apidia; 36.86963°N, 22.81469°E; 225 m; 26.6.2015; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Evrotas, Kremasti; 36.96796°N, 22.88843°E; 915 m; 26.6.2015; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Evrotas, Kremasti, Mt. Chionovouni; 36.98611°N, 22.90383°E; 867 m; 26.6.2015; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Evrotas, Kremasti, Mt. Madara (1); 37.02908°N, 22.88890°E; 939 m; 22.6.2015; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Evrotas, Kremasti, Mt. Madara (2); 36.97684°N, 22.89841°E; 967 m; 26.6.2015; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Arkadia: Aghios Andreas, Orino Korakovouni; 37.30297°N, 22.74752°N; 341 m; 4.6.2016; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar
GR: Peloponnese: Arkadia: Aghios Andreas, Orino Korakovouni; 37.30487°N, 22.75005°N; 400 m; 4.6.2016; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar
GR: Peloponnese: Arkadia: Aghios Andreas, Orino Korakovouni; 37.29536°N, 22.76495°N; 668 m; 4.6.2016; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar

GR: Peloponnese: Arkadia: Aghios Andreas, Orino Korakovouni; 37.29964°N, 22.76597°N; 649 m; 4.6.2016; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar

Mezammira cf. *sakisi*

GR: Peloponnese, Messinia, Mani Peninsula, Saidona, Mt. Taygetos; 36°53.415'N, 22°18.957'E; 1142 m; 30.6.2013; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Laconia: Mani Peninsula: Aghios Nikolaos, Panaghia Giatrissa; 36°50.666'N, 22°23.416'E; 948 m; 30.6.2013; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Messinia: Mani Peninsula: Anatoliko, Kaskarakas Gorge (Rintomo Gorge); 36°58.822'N, 22°15.561'E; 689 m; 26.6.2014; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Messinia: Mani Peninsula: Karea; 36°58.929'N, 22°17.605'E; 1097 m; 26.6.2014; collected, recorded, fotographed; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Messinia: Mani Peninsula: Kokkinovouni; 36°58.803'N, 22°16.951'E; 1164 m; 26.6.2014; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Messinia: Mani Peninsula: Mt. Kalathi, Dendra; 37°00.325'N, 22°14.323'E; 1100 m; 25.6.2014; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Messinia: Mani Peninsula: Mt. Kalathi, Kria Vrisi; 37°00.562'N, 22°15.962'E; 1103 m; 25.6.2014; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Messinia: Mani Peninsula: Mt. Kalathi, Rizana; 37°01.253'N, 22°16.408'E; 1156 m; 25.6.2014; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Messinia: Mani Peninsula: Platoma, Koskarakas Gorge; 36°57.351'N, 22°11.371'E; 183 m; 27.6.2014; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: Peloponnese: Messinia: Mani Peninsula: Saidona; 36°53.102'N, 22°17.701'E; 888 m; 27.6.2014; recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.

Mezammira filoti sp. nova

GR: South Aegean, island Naxos: Filoti; 37°02.487'N, 25°29.685'E; 436 m; 21.6.2014; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.
GR: South Aegean, island Naxos: Filoti; 37°02.484'N, 25°29.690'E; 451 m; 22.6.2014; collected, recorded; M.Gogala, T.Trilar, K.Prosenc Trilar.

Mezammira tibialis (Panzer, 1798)

GR: Central Macedonia: Pieria: Litochoro; 40.11146°N, 22.49306°N; 341 m; 29.5.2016; collected (3♂), recorded; M.Gogala, T.Trilar, K.Prosenc Trilar

Table 2: Morphological and bioacoustic traits for 6 *Mezammira* taxa from Greece (Grey – new taxa).

MORPHOLOGY	*M. flaveola*	*M. carayoni*	*M. goumenissa*	*M. filoti* 5♂1♀	*M. sakisi* 12♂3♀(E. Peloponnese)	*M.* cf. *sakisi* 2♂ (Taigetos)
apical cells forew.	8 (7-9)	8	8	♂7-8, ♀8 (9)	8 (9 unilat 2x)	8
apical cells hindw.	5 (3-6 also bilat.)	6 (5 unilat)	6	5 (6 unilat.)	5 (6 unilat 4x)	5 (6 unilat)
pronotum coloration	basal spot free,broad yellow mediane (3 specimens of 49 like *M. filoti*)	dark, yellow med., 1 lighter freshly hatched spec. ♂. with smudged spot	Like *M. carayoni*, black, sometimes yellow mediane distally	pronotum:dark basal spot connected with lateral dark fields	pronotum dark, no basal spot, only front and hind edges lighter	basal spot connected with lateral dark fields, broad yellow mediane
ulnar1/apikal1 cell	1.9	1.4	♂♂1-1.1 ♀♀1.1-1.2	1.4-2.3	1.4±0.1	1.8, 2.5
pronotum w/lwith collar w/l	2.01±0.06, conical 2.38±0.08	1.96±0.05, barrel 2.37±0.04	1.89±0.05, barrel 2.24±0.07	2.0, conical	2.0±0.12.4±0.1	1.8, barrel
MCuA/Arc	1.23 (0.5-2.5!)	1.17 (0.9-1.6)	≈1	0.9-1.5	1.5±0.4 (0.9-2.0)	1.27 (1-1.7)
Body length [mm]	♂♂13.9±0.8 (13.7-15.6) ♀♀ 13.9-14.7	14.1±0.7(13.0-15.1)	♂♂13 (12.4-13.8) ♀♀14.5 1	♂♂12.5±0.6 (12.0-13.7) ♀12.0	♂♂10.3-12.8 ♀♀11.6-13.7	♂♂11.6, 13.7
eye color (alive)	yellow	brown	brown	red	black	reddish brown
abd.stern. 8/7	0.85 (0.8-0.9)	1.04	1.0-1.2	0.95	0.8 - 0.9	0.94

ACOUSTICS	*M. flaveola*	*M. carayoni*	*M. goumenissa*	*M. filoti*	*M. sakisi* (E. Peloponnese)	*M.* cf. *sakisi* (Taigetos)
song structure	SSS/LSSL/LSLS phrases ABC	SSS/LSSL/LLL	SSS/SSSL/LLVL	MMM/LSSL/SSSL	MMM/LMLM/SSSL phrases ABC	MMM/LMLM/SSSL phrases ABC
Repetition rates [Hz]	MMM SE rep.r. 7-11	SE rep.r. A 8.9±1 B 9.3±1	MMM(2013) SE rep. r. 19±3-10±2	MMMSE rep.r. 7.7-8.7	MMM rep.r. 9 LSLS rep.r. 10.5 LSSL rep.r. 10.3	MMM rep.r. 8.2 LSLS rep.r. 12.6 LSSL rep.r. 13.3
MMM M dur/int [ms]	S: 8±1, M: 16-18, 25-29 Int 70-110	M: 21.9±4.5 Int 91.6±14.3	M: 26±7Int 25.8±0.6	M: 24.2±1.4 Int 96.6±0.6	M: 33.1±5.1 Int: 80.3±9.1	M: 30±10 Int: 79.1±29.4
LSS(S)L S/M L dur [ms,s]	S: 8, 16 L: 62-70	S: 6.3±1.2 L: 44.2±5.3	M: 26±7L: 535±88 VLE: <15s!	S: 5.3±1.6 L: 73,9±3.8	S: 11.4±4.9 L: 69.6±8.6 Int: 75.1±17.8 Int (LE): 44.6±10	M: 21.3±7.6 L: 58.4±8.7 Int: 58.2±13.3
$N_{L/group}$ $N_{S/L-L}$	$N_{L/group}$=5 (median) $N_{S/L-L}$ =2 (median)	$N_{L/group}$=9 (median) $N_{S/L-L}$=3 (median)	NA	$N_{L/group}$=10 (median) $N_{S/L-L}$ =2 (median)	$N_{L/group}$=5 (median) $N_{S/L-L}$ =3 (median)	$N_{L/group}$=4 (median) $N_{S/L-L}$ =3 (median)
LSLS S/L dur [ms]	S: 12.8±5.1 L: 51.2±4.7 Int: 62.6±9.2	NA	NA	NA	S: 20.3±4.7 L: 83.1±8.8 Int: 42.5±10	S: 36.7±8.8 L: 86.8±12.2 Int: 26.2±9.5
Frequency 5/CFr/95% [kHz]	10.2 **12.7** 14.2	11.3 **13.6** 15.2	15.5 **19.6** 22.1	10.8 **13.9** 17.8	16.7 **18.7** 20.6	14.7 **16.9** 19.5

Table 3: Carrier frequencies of 6 Greek *Mezammira* taxa. 5% and 95% frequency energy values give the lower and upper frequency limit of effective sound range. Max frequency values shown in this tables is very close to Center frequency values (50%), shown in Fig. 23 - see the explanation in Raven Pro Instruction manual (Grey – new taxa).

Taxon	*Mezammira carayoni*			*Mezammira flaveola*			*Mezammira filoti*		
Freq.	5%	95%	Max	5%	95%	Max	5%	95%	Max
COUNT	92	92	92	91	91	91	84	84	84
AVERAGE	11301	15182	13641	10175	14158	12697	10826	17790	13895
STDEV	270	314	657	309	407	593	1126	918	931
MEDIAN	11250	15375	13875	10313	14250	12750	11532	17813	13875
QUART 1	11063	15000	13313	9938	13875	12375	9750	17063	13500
QUART 3	11438	15375	14063	10313	14438	13125	11813	18563	14625
MIN	9938	14250	11250	9563	13313	10125	9188	15938	10500
MAX	11813	15563	14250	10875	15563	13500	12188	18938	16125

Taxon	*Mezammira* cf. *sakisi* (Taygetos)			*Mezammira sakisi* (E. Peloponnese)			*Mezammira goumenissa*		
Freq.	5%	95%	Max	5%	95%	Max	5%	95%	Max
COUNT	105	105	105	20	20	20	29	29	29
AVERAGE	14723	19468	16918	16650	20625	18675	15517	22125	19552
STDEV	94	99	485	776	655	481	1564	317	165
MEDIAN	14813	19500	16875	16969	20438	18750	15750	22125	19500
QUART 1	14625	19500	16688	16078	20250	18563	15750	21750	19500
QUART 3	14813	19500	17438	17250	20859	18938	16125	22500	19500
MIN	14625	19313	14813	14813	19688	17625	9375	21750	19125
MAX	14813	19688	18938	17625	21938	19688	16125	22875	19875

ACTA ENTOMOLOGICA SLOVENICA

LJUBLJANA, JUNIJ 2017 Vol. 25, št. 1: 65–74

LIMOTETTIX CARNIOLICUS SP. NOV., A NEW WEST-PALAEARCTIC LEAFHOPPER SPECIES (HEMIPTERA, CICADOMORPHA, CICADELLIDAE)

Gabrijel SELJAK

Kmetijsko gozdarski zavod Nova Gorica,
Pri Hrastu 18, 5000 Nova Gorica, Slovenia
e-mail: gabrijel.seljak@gmail.com

Abstract - A new species of the leafhopper genus *Limotettix* Sahlberg 1871 is described. In outer appearance it is similar to *L. ochrifrons, L. aviger* and related species. It is easily distinguishable from all other species of the genus by the peculiar shape of aedeagus and by its smaller body size. The species was found in western Slovenia in a montane intermediate bog living on *Eleocharis quinqueflora*, most probably monophagously. It is univoltine and hibernates in the egg stage. Adults have been found from early July until mid-August. Temporary, the species is considered as highly vulnerable and in danger of extinction.

KEY WORDS: Cicadomorpha, new species, Slovenia, intermediate bog.

Izvleček – *LIMOTETTIX CARNIOLICUS* SP. NOV., NOVA ZAHODNOPALEARKTIČNA VRSTA ŠKRŽATKA (HEMIPTERA, CICADOMORPHA, CICADELLIDAE)

Opisana je nova vrsta škržatka iz rodu *Limotettix* Sahlberg 1871. Po zunanjosti je podobna vrstam *L. ochrifrons, L. aviger* in njima podobnim vrstam. Od podobnih vrst tega rodu se razlikuje predvsem po svojski obliki aedeagusa in manjši telesni velikosti. Vrsta je bila najdena v zahodni Sloveniji v montanskem prehodnem barju na malocvetni siti (*Eleocharis quinqueflora*), verjetno edinem gostitelju. Razvije en rod na leto in prezimuje kot jajčece. Odrasli škržatki se pojavljajo od začetka julija in vsaj do sredine avgusta. Vrsta je začasno opredeljena kot zelo ranljiva in v nevarnosti za izumrtje.

KLJUČNE BESEDE: Cicadomorpha, nova vrsta, Slovenija, prehodno barje

Introduction

The genus *Limotettix* belongs to the subfamily Deltocephalinae Fieber 1869 and according to most authors to the tribe Athysanini Van Duzee 1892 (Anufriev & Emeljanov, 1988; Hamilton, 1994; Holzinger & al., 1997). Recently, Zahniser & Dietrich (2013) have placed it into the tribe Limotettigiini Baker, 1915, which includes only *Limotettix* s.l., *Ophiola, Ophiolix* and *Scleroracus*. Leafhoppers of the genus *Limotettix* have a cosmopolitan distribution. However, the great majority of species are confined to latitudes north of 40°N of the northern hemisphere. The ancestral origin of this genus is assumed to be North America, where the fauna of this genus is comparatively rich and diverse (Hamilton, 1994). This genus has received a rather diverse taxonomic interpretation among authors. The majority of European authors treat it in a restricted sense, where only the subgenera *Limotettix* Sahlberg 1871 s. str., *Neodrylix* Emeljanov 1966 and *Dryola* Hamilton 1994 are included. The subgenera *Ophiolix* Ribaut 1942 and *Scleroracus* Van Duzee are placed as separate genera or as subgenera of the genus *Ophiola* Edwards 1922 (Emeljanov, 1966; Ossiannillson, 1983; Nast, 1987; Biedermann & Niedringhaus, 2004). On the other hand, American and some other authors consider this genus in a broad sense with all the above mentioned (sub)genera included in a single genus *Limotettix* (Ribaut, 1952; Anufriev & Emeljanov, 1988; Hamilton 1994; Zahniser, 2007). Here, I follow the restricted interpretation of the genus *Limotettix*.

This genus comprises currently about 35 described species that are allocated in three subgenera: subgenus *Limotettix* - 28 species, *Neodrylix* - 5 species and *Dryola* - 2 species (Zahniser, 2007). All Palaearctic species (16 in number) belong to the subgenus *Limotettix* s. str., while the subgenera *Neodrylix* and *Dryola* are entirely Nearctic (Emeljanov, 1966; Hamilton, 1994). The majority of the Palaearctic species

Fig. 1: *Limotettix carniolicus* sp. n. - male

Fig. 2: *Limotettix carniolicus* sp. n. - female

occur very scattered over the vast area of Russia and adjacent countries. Outside of Russia, four species have been recorded in Europe. Only *L. striola* (Fallén 1806) is widely distributed across Europe, while *L. atricapillus* (Boheman 1845), *L. ochrifrons* Vilbaste 1973 and *L. sphagneticus* Emeljanov 1966 are confined to the north-eastern Europe (Ossiannilsson, 1983; Nast, 1987). All these species inhabit permanent moist peatland, raised bogs and fens and are associated with various Cyperaceae, mostly *Eleocharis* spp. (Hamilton, 1994; Nickel, 2003).

Fig. 3: *Limotettix carniolicus* sp. n. - head of a male

Fig. 4: Type locality of *L. carniolicus* sp. n.

In Slovenia, only *L. striola* has been recorded so far and has been revealed as rather rare and scattered throughout (SELJAK, 2004; SELJAK, 2016). During entomological trips in summer 2016 another *Limotettix* species was discovered in a montane intermediate bog near the village Vojsko, which differs from all species described so far by a very characteristic shape of its aedeagus. It is described here as a new species.

The genus *Limotettix* is well defined by the combination of the following characters: distinctive dark patterns on the head, short male anal tube with little expanded dorsal sclerotization, strong dorsal processes on pygopher, disorderly arranged setae on the lower side of the subgenital plates, connective Y-shaped with long base and shorter branches; short and stout aedeagus indistinctly separated from the base; sclerotized dorsal phragma articulates free with the base (OSSIANNILSSON, 1983, ANUFRIEV & EMELJANOV, 1988). There is no monographic work dealing with the Palaearctic *Limotettix* species. Data on single species are mainly scattered in different papers. Emeljanov's account on this genus is still the most comprehensive one, dealing with 10 species occurring in the territory of former USSR (EMELJANOV, 1966). The most comprehensive taxonomic and evolutionary study on Nearctic species of the genus *Limotettix* s. l. was done by HAMILTON (1994) providing also an illustrated comparative set of morphological details for all North-American species.

Material and methods

The holotype and all paratypes were dry mounted on mounting boards of appropriate size. The holotype male (♂) and the allotype female (♀) are designated with a red label. The holotype, allotype and four paratype specimens (2 ♂♂ and 2 ♀♀) have

been deposited in the Slovenian Museum of Natural History (SMNH). The rest of the material is currently in the author's private collection. Drawings were handmade on the basis of microscopic photographs of single details. Photographs of subgenital plates, the stylus and connective have been applied directly after they were processed with Adobe Photoshop software. Colour photographs were taken with a Canon EOS 70D camera by using the lenses Canon MP-E 65mm and Canon EF-S 18-135mm.

Description

***Limotettix (Limotettix) carniolicus* sp. nov.**

Material examined: Holotype: 1 ♂ - dry mounted, 8.8.2016, Vojsko (Gačnik) - 910 m (coord.: 46°03' N/ 13°52' E); paratypes: same locality 12.7.2016 (1 ♀); 3.8.2016 (8 ♂♂ and 15 ♀♀) and 8.8.2016 (26 ♂♂ and 28 ♀♀).

Etymology: The name derives from the historical name of the central region of what is nowadays Slovenia (Carniola, Krain, Kranjska), where the species occurs.

Body length: Rather small for the genus; males 3.2 - 3.8 mm (holotype: 3.47 mm), females 3.5 - 4.2 mm (n = 25+25 - fresh specimens).

Male (Figure 1): Head typical for the genus; clearly broader than pronotum, broadly rounded frontally, yellow to pale yellow; vertex subparallel, in the middle only slightly longer than near the eyes; a sharp black band runs between the eyes just

Fig. 5: *Limotettix carniolicus* sp. n. - head of a female
Fig. 6: *Eleocharis quinqueflora*, the host plant of *L. carniolicus* sp. n.

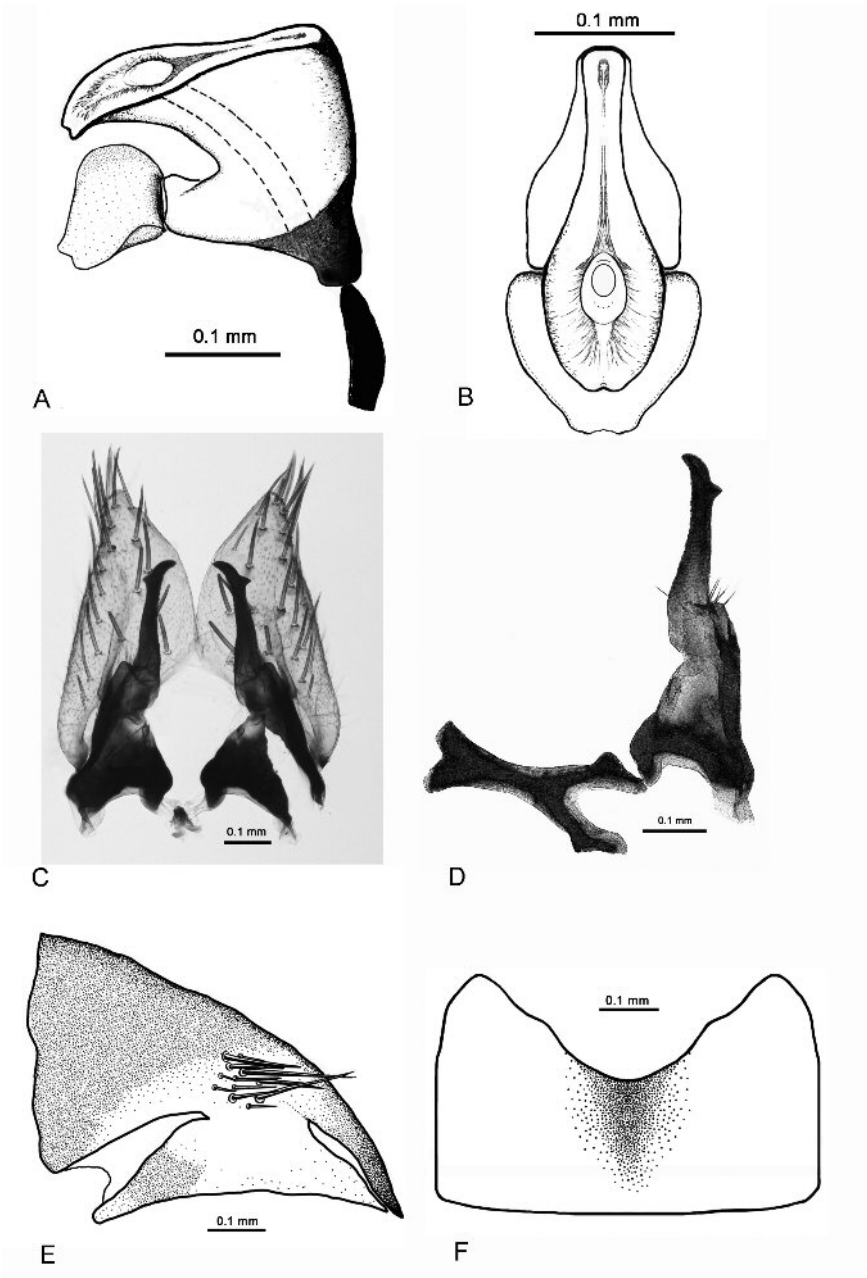

Fig. 7: *Limotettix carniolicus* sp. n.: A - aedeagus (postero-lateral view); B - same (posterior view); C - subgenital plates and styluses; D - left stylus and connective; E - left pygofer; F - female's sternite VII.

behind the ocelli (only rarely it may be interrupted by paler sections), continuing ventrad along the inner eye margin and fusing with two semi-separated spots on the inner eye margin. In specimens with paler band, a dark brown to black spot is always present behind of each ocellus just at the point where frontal sutures terminate; light interocellar band distinct for its whole extend. Face base colour pale yellow, frontoclypeus with 7- 8 black to brown transverse streaks; the upper two or three fused in the middle in a black macula, the others fused medially with two parallel longitudinal bands that are divided by a light median stripe (Figure 3); anteclypeus regularly parallel-sided, normally dark edged and with a median brown to black elongated patch; lorae mainly dark edged; area around antennae slightly nigrescent. First antennal segment yellow or rarely with a dark dorsal patch; second segment mainly bicoloured, the basal half or two thirds dark (brown to black), yellow on the apex. Pronotum narrower than the head, yellow, semi-transparent in the distal half, very subtle transversely wrinkled (observe at lateral light fall); scutellum uniformly yellow with the scare right in the middle. Legs yellow with dark dotted longitudinal patches or strips on femur; the inner side of the hind tibia mainly dark brown to black at least in the upper half, the outside macrosetae of the hind tibia arise from dark spots; hind tarsal segments as well as hind tibia darkened apically. Fore wings longer than abdomen, transparent pale yellowish, in apical cells slightly fumose, venation bright yellow; hind wing transparent, veins in apical third brownish; abdomen predominantly black or dark brown with yellow side margins; genital segment in general yellow, but genital valve sometimes darkened.

Female (Figure 2): In general brighter than the males in all body parts; transversal band on vertex is mainly much paler, light to ± darker brown, sometimes almost dissolved; in some specimens the middle part of the band may be darker; a small spot behind each ocellus, just at the point where frontal sutures terminate, but inside the band, always present and mostly much darker than the band itself, black to dark brown, in specimens with dark band not clearly noticeable (Figure 5). Also transversal streaks on frontoclypeus are mostly significantly paler than in males, the upper one or two, rarely three fused in the middle.

Male genitalia: **Anal tube** short with deep dorsal excision at the base. **Lobes of pygofer** typical for the genus with a dorsal down directed process on each (Figure 7D); a cluster of setae at the base of these processes; **genital valve** broad triangular, roughly 2.5 times as broad as long. **Subgenital plates** elongated triangular with slightly attenuate apices, diverging in the apical half, medially approximately as long as at the base broad; lateral margins more or less straight; setae yellowish brown, arranged disorderly over the entire lower surface; **Stylus** apically angled with inwards directed apices, looks like an upside turned human leg (Figure 7C), distal part transversely rugose especially the inner side. **Connective** is typical for the genus, Y-shaped, its stem longer than the fork (Figure 7C). **Aedeagus** very unusual for the genus, in lateral view like an upside turned ankle boot (Figure 7A and B), aedeagal shaft well developed laterally strongly compressed, distal part flat, ventrally very narrow, widening then gradually towards the gonopore area; apex in lateral view sharp thinned and slightly twisted basad, rounded and with a shallow apical notch in

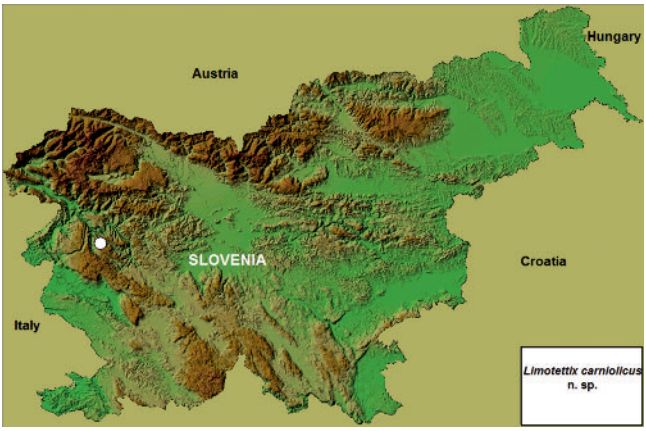

Fig. 8: *Limotettix carniolicus* sp. n. - type locality

posterior view, but without apical teeth; gonopore is in a small depression, which is placed towards the apical third; basal phragma sclerotized, broadly cordate in dorsal view, free articulated with the phalobase.

Female genitalia: ventral border of sternite VII (Figure 7E) concave, broadly V-shaped, medially half as long as on its margins, mostly with a brown or black median streak or patch; gonoplacs dark brown to black, bright towards the apex and as long as or only slightly longer than the pygofer (tergite IX).

Diagnosis

In outer appearance, this new species is similar to *L. atricapillus* (Boheman 1845), *L. aviger* Emeljanov 1964, *L. ochrifrons* Vilbaste 1973 and related species, but markedly smaller. The most distinguishing character is the characteristic shape of aedeagus; its apex is only shallowly notched but with no apical teeth and distinctly remote from the dorsal base, so that the shaft builds a clear lamellate stem. Most probably, females cannot be reliably discriminated by morphological characters, except perhaps by smaller size.

Host plant: *Eleocharis quinqueflora* (Hartmann) O. Schwarz (Cyperaceae) (Fig. 6); 1st degree monophagous at the type locality. Further findings on other localities are necessary to find out its real diet breadth.

Life history: Like all other species of the genus *Limotettix* also *L. carniolicus* hibernates in egg stage. First - still teneral - specimens were caught on July 12. The species is more abundant in August. According to my observations, the species is univoltine.

Distribution: Currently, *L. carniolicus* is only known from the type locality (Figures 4 and 8). Several other wetland habitats in the area were visited during summer 2016; however, no specimens of this species were found. The species is most probably monophagous on *Eleocharis quinqueflora*. This plant species is rather rare in Slovenia (JOGAN & al., 2001) and also in rapid decline because of continuous loss of wetland habitats. However, there are still many fens and intermediate bogs along the Dinaric mountain chain and in South-eastern Alps that might be suitable habitats for the species.

Conclusions

L. carniolicus is apparently another relict of the last glaciations in Europe. The unusual aedeagus shape that significantly differs from all other Palaearctic as well as from Nearctic species suggests a rather ancient separation from other related species. It might be another case of east-Alpine or Dinaric endemism. As the whole known population is limited to a single patch of the host plant covering only a few square metres in a permanently moist intermediate bog, the species is highly vulnerable and in high risk of extinction.

Acknowledgements

I am obliged to Michael M. Wilson (National Museum Wales, Cardiff, United Kingdom) for his kind help in providing the literature on the genus *Limotettix*. I also thank Christoph Bückle, who kindly shared with me his original drawings of the male genitalia of a paratype of *Limotettix aviger* for comparison. Many thanks also to doc. Dr. Meta Virant Doberlet (Nacionalni inštitut za biologijo, Ljubljana) for the improvement of the English text.

References

Anufriev, G.A., Emelyanov, A.F. 1988. Suborder Cicadinea (Auchenorrhyncha). In Lehr, P.A. (ed.): Keys to the insects of the far east of the USSR. Volume 2, Homoptera and Heteroptera: p 12-496. Nauka Leningrad.

Biedermann, R., Niedringhaus, R. 2004: Die Zikaden Deutschlands - Bestimmung Tafeln für alle Arten. Wissenschaftlich Akademischer Buchvertrieb-Fründ, Scheeßel: 409 pp.

Emeljanov A. F. 1966: New palaearctic and certain nearctic cicadina (Homoptera, Auchenorrhyncha). *Entomologicheskoe Obozrenie* 45(1): 95-133.

Hamilton, K. G. A. 1994: Evolution of *Limotettix* Sahlberg (Homoptera: Cicadellidae) in peatlands, with descriptions of new taxa. *Memoirs of the Entomological Society of Canada.* 169:111-133.

Holzinger W. E., Fröhlich W., Gunthart H., Lauterer P., Nickel H., Orosz A., Schedl W. & Remane R. 1997: Vorläufiges Verzeichnis der Zikaden Mitteleuropas (Insecta: Auchenorrhyncha). *Beiträge zur Zikadenkunde* 1: 43-62.

Jogan N., Bačič T., Frajman B., Leskovar I., Naglič D., Podobnik A., Rozman B., Strgulc-Krajšek S., Trčak B. 2001. Gradivo za Atlas flore Slovenije. Center za kartografijo favne in flore, Miklavž na Dravskem polju, 443 pp.

Nast J. 1987: The Auchenorrhyncha (Homoptera) of Europe. *Annales Zoologici Warszawa* 40: 535-661.

Nickel H. 2003: The Leafhoppers and Planthoppers of Germany (Hemiptera Auchenorrhyncha): Patterns and strategies in a highly diverse group of phytophageous insects. Copublished by Pensoft Publishers, Sofia-Moscow and Goecke & Evers, Keltern: 460 pp.

Ossiannilsson, F. 1983: The Auchenorrhyncha (Homoptera) of Fennoscandia and Denmark. Part 3: The familiy Cicadellidae, Deltocephalinae, Catalogue, Literature and Index. *Fauna Entomologica Scandinavica 7* (3): 594-979.

Ribaut H. 1952: Homopteres Auchenorhynques II (Jassidae). *Faune de France* 57: 1-474.

Seljak G. 2004: Contribution to the knowledge of planthoppers and leafhoppers of Slovenia (Hemiptera: Auchenorrhyncha). *Acta Entomologica Slovenica* 12 (2): 189-216.

Seljak G. 2016: New and little known plant- and leafhoppers of the fauna of Slovenia (Hemiptera: Fulgoromorpha and Cicadomorpha). *Acta Entomologica Slovenica* 24 (2): 151-200.

Zahniser J.N. 2007: An online interactive key and searchable database of Deltocephalinae (Hemiptera: Cicadellidae). http://zahniser.speciesfile.org/taxahelp.asp.

Zahniser J.N. & Dietrich C.H. 2013: A review of the tribes of Deltocephalinae (Hemiptera: Auchenorrhyncha: Cicadellidae). *European Journal of Taxonomy* 45: 1-211.

Received / Prejeto: 2. 3. 2017

ACTA ENTOMOLOGICA SLOVENICA

LJUBLJANA, JUNIJ 2017 Vol. 25, št. 1: 75–88

THE OCCURRENCE OF *DERMACENTOR RETICULATUS* TICK (ACARI: AMBLYOMMIDAE) IN NORTH-EAST SLOVENIA: ONE MORE EVIDENCE FOR ITS INCREASED DISTRIBUTION RANGE

Maja Gračner Jadresic[1], Roman Luštrik[2], Tomi Trilar[3]

[1] maja.gracner@gmail.com
[2] Department of biology, Biotechnical faculty, University of Ljubljana, Večna pot 111, SI-1000 Ljubljana, Slovenia, e-mail: romunov@gmail.com
[3] Slovenian Museum of Natural History, Prešernova 20, 1000 Ljubljana, Slovenia, e-mail: ttrilar@pms-lj.si

Abstract – The occurrence of *Dermacentor reticulatus* on the territory of Slovenia was not described before. By extensive 3.5 year sampling period, we obtained sufficient data allowing for the first time to clearly define the distribution rate and seasonal activity of adult *D. reticulatus* in this part of Europe, north-east Slovenia. A study was conducted from November 2003 to May 2007 to evaluate the comprehensive view of the annual seasonality of questing adult *D. reticulatus*. Ticks monitoring was conducted in three different localities/habitats: a) Muriša - wet meadows near oxbow lake of the river Mura; b) Murska šuma - swampy forest area between the confluence of the river Mura and Ledava, which is occasionally flooded; and c) Dolinski pašnik - meadows with old oak trees, forest edge and shrub communities. In total, 2511 ticks were collected by flagging. There were exclusively adults with female-biased sex ratio throughout the years in all sampling localities, namely for Muriša 59.5% (1287 of 2164), Murska šuma 62.7% (203 of 324) and Dolinski pašnik 60.8% (14 of 23). Most of the ticks (89.2%) were collected when the mean daily temperatures were ranging from 0 to 14.9ºC. The highest activity of *D. reticulatus* were noted in the spring, culminating in February-April/May, peaking in average in March and with considerably lower rate (3-8-times) in the second activity peak in autumn, culminating in the end of August/September-November. The greatest number of adults in autumn was collected in October or November. *Dermacentor reticulatus* was not active during the summer months. The highest quantity of ticks was recorded in meadows near oxbow lake of the river Mura where was caught 6.6-times more ticks than in swampy forest area Murska šuma, which was occasionally flooded after huge rainfall and

even 94-times more than in Dolinski pašnik. The confirmed occurrence of *D. reticulatus* in north-eastern Slovenia provided evidence that this species has extended its range. Our findings point to an enlargement of Pannonian distribution area of the species. This study indicates that *D. reticulatus* can be ranked as a typical element of the fauna in north-eastern Slovenia.

KEY WORDS: *Dermacentor reticulatus*, Slovenia, distribution, seasonality

Izvleček – POJAVLJANJE SEVERNEGA ORNAMENTIRANEGA KLOPA (*DERMACENTOR RETICULATUS*) (ACARI: AMBLYOMMIDAE) V SEVEROVZHODNI SLOVENIJI: ŠE EN DOKAZ ZA POVEČANJE NJEGOVE RAZŠIRJENOSTI

Pojavljanje severnega ornamentiranega klopa (*Dermacentor reticulatus*) v Sloveniji do sedaj ni bilo opisano. Z obsežnim tri in pol letnim vzorčenjem, od novembra 2003 do maja 2007, smo na treh lokalitetah (Muriša, Murska šuma in Dolinski pašnik) v severovzhodni Sloveniji v Prekmurju na območju Lendavskega Dolinskega pridobili dovolj podatkov, s katerimi smo dobili vpogled v razširjenost in sezonsko aktivnost severnega ornamentiranega klopa. Skupno smo nabrali 2511 odraslih osebkov klopov. Odrasli osebki severnega ornamentiranega klopa so bili na vseh lokalitetah najbolj aktivni spomladi, z vrhom v marcu. Aktivnost se je proti poletju počasi zmanjševala in v poletnih mesecih klopov nismo našli. Ponovno se je aktivnost povečala v jesenskih mesecih, z manjšim vrhom v oktobru ali novembru (3-8-krat manjša aktivnost kot spomladi). Vrsta je bila najbolj številčna ob Muriši, kjer je bilo ujetih 6,6-krat več odraslih osebkov kot v Murski šumi, ki je bila občasno poplavljena, in 94-krat več osebkov kot na Dolinskem pašniku. Razmerje med spoloma je bilo na vseh lokalitetah v prid samic, in sicer ob Muriši z 59,5 % (1287 od 2164), v Murski šumi 62,7 % (203 od 324) in na Dolinskem pašniku 60,8 % (14 od 23). Večina klopov (89,2%), je bilo nabranih pri povprečni dnevni temperaturi od 0 do 14,9ºC.

V članku sta prvič predstavljeni razširjenost in sezonska aktivnost severnega ornamentiranega klopa (*Dermacentor reticulatus*) v Sloveniji. Naše ugotovitve kažejo na povečanje panonskega območja razširjenosti in da predstavlja severni ornamentirani klop značilni favnistični element severovzhodne Slovenije.

KLJUČNE BESEDE: severni ornamentirani klop, *Dermacentor reticulatus*, Slovenija, razširjenost, sezonska aktivnost

1. Introduction

Dermacentor (Dermacentor) reticulatus (Fabricius 1794) is a hard tick species (Acari: Ixodida: Amblyommidae), which has a large geographical range across the temperate zone (Buczek et al. 2014) and is within its geographic range divided into two separate parts, Western and Eastern Europe. Western European part includes populations from the western Palaearctic region, in a temperate zone from England and France while the eastern European part extends to the Basin of Yenisei River in

Siberia and to Central Asia (Dautel et al. 2006, Karbowiak 2014). The tick species has not been found north of 53º-54ºN latitude nor in Mediterranean climate zone (Dautel et al. 2006). The currently known southern distribution of *D. reticulatus* in the Balkans is in Serbia near Belgrade at 44.77ºN 20.36ºE. The southernmost occurrence of this species is found in the Crimean Peninsula at 44.27ºN 34.03ºE (Rubel et al. 2016). The area of distribution as a whole is expanding and the expansion to new, previously free areas has been observed in several countries in Europe (Nowak 2011, Karbowiak 2014, Földvári et al. 2016, Rubel et al. 2016).

There are 36 species known in the genus *Dermacentor* (Barker and Murrell 2008), with two of them in Slovenia: *Dermacentor reticulatus* (Ornate Cow Tick) and *Dermacentor marginatus* (Ornate Sheep Tick). According to the data from the Ixodida study collection (PMSL-Ixodida) housed in Slovenian Museum of Natural History (Trilar, unpublished data) we are considering that in Slovenia *D. reticulatus* is distributed north of the river Sava (commonly found in the north-east Slovenia) and *D. marginatus* south of the river Sava.

Until the present research had been conducted, there were only few reports of adult *D. reticulatus* from north-east Slovenia, found for the first time in May 2001 from vegetation and later on Red Deer (*Cervus elaphus* Linnaeus 1758) in autumn 2002. There are also data of adult *D. reticulatus* found on dogs (*Canis familiaris* Linnaeus 1758) from Ljubljana in August 1995 and Brežice from year 2003 (south-east Slovenia). Dog could be with owner anywhere in Slovenia or Croatia, or even further, so we cannot know from where the ticks originally came from. *Dermacentor reticulatus* were from year 2003-2007 commonly found in the north-east Slovenia (Figure 3).

Dermacentor reticulatus is the second most reported tick species after *Ixodes ricinus* (Linnaeus 1758) in Central Europe (Rubel et al. 2016) and considered to be among important vectors of tick-borne diseases of animals and human (Široký et al. 2011, Földvári et al. 2016). Research results from Central and Eastern European countries are suggesting that *D. reticulatus* may have changed its spatial distribution and its geographic range (Sréter et al. 2005). Large areas of north-western and central Europe, formerly thought to be too cold for its survival and completion of life-cycle, have experienced a remarkable expansion of this species (Földvári et al. 2016). Given its vectorial capacity, expansion of *D. reticulatus* can affect the occurrence of certain diseases (Cochez et al. 2012) as canine babesiosis, tularemia, rickettsiosis, or Q fever and playing role in forming their natural foci (Řehaček et al. 1991, Hubálek et al. 1996, 1998, Parola et al. 2005, Duh et al. 2006, Dobec et al. 2009). Indeed, in Europe, *D. reticulatus* are the most important vectors of *Babesia canis canis*, the aetiological agent of canine babesiosis (Uilenberg et al. 1989, Lobetti 1998). In Slovenia it is expected the majority if not all cases of canine babesiosis to be caused by *B. c. canis* (Duh et al. 2004).

Studying tick ecology is crucial for better understanding of the risk this tick species poses to animal and human populations. The present survey is undertaken in order to gain comprehensive view of the annual seasonality of *D. reticulatus* in Slovenia and fully proves for the first time that *D. reticulatus* occurs in Slovenia, in the area Lendavsko Dolinsko in Prekmurje (Pannonian biogeographical region), in less

than 1 km distance to the Slovenian-Hungarian and Slovenian-Croatian border, in the area where no natural populations of this species had been discovered until now.

2. Materials and methods

2.1 Study area

The study was conducted in three localities in the north-eastern part of Slovenia - Lendavsko Dolinsko area, Prekmurje: a) Muriša (46°29'08"N 16°33'11"E; 157m above sea level [a.s.l.]), b) Murska šuma (46°30'29"N 16°31'53"E; 155m a.s.l.) and c) Dolinski pašnik (46°31'46"N 16°29'54"E, 158m a.s.l.). Each locality represented different habitat type:

Oxbow lake Muriša: meadows near oxbow lake of the river Mura; the shoreline of oxbow lake was densely overgrown with True Sedge (*Carex* sp.), Common Reed (*Phragmites australis*) (Skoberne 1988) and with allochtonous plant species as Policeman's Helmet (*Impatiens glandulifera*) and Giant Goldenrod (*Solidago gigantea*),

Murska šuma: swampy forest area between the confluence of the river Mura and Ledava, occasionally flooded and overgrown by Common Hornbeam, Pedunculate Oak Forest (*Carpino betuli-Quercetum roboris*) and

Dolinski pašnik: meadows with old Pedunculate Oak trees (*Quercus robur*), forest edge and shrub communities (Gogala 2002). Part of the area was used as a football field.

Localities are separated by a distance from 1.8 to 5 km. Distance from the Slovenian-Hungarian and Slovenian-Croatian border is less than 1 km.

The study area is located in temperate zone with continental climatic impact of large temperature fluctuations, cold winters and hot summers with little rainfall, which are most abundant in July. The average annual temperature is 10-12°C. Average annual rainfalls for this area are 800-1000mm (Mršić 1997). Snow can appear from November-March but persists in each month for a short time. On 30 years average (from 1971-2000) were in north-eastern Slovenia 5-20 days of snow cover per year (data from the Slovenian Environment Agency).

2.2 Tick collection

Ticks collections were performed on a monthly basis for 1 consecutive day from November 2003 to May 2007. The choice of study days depended on weather conditions. No collection of ticks was arranged after snowfall or on a wet snowmelt days (in January and February 2005, in November 2005 till February 2006 and in December 2006 till January 2007) and after heavy rains with floods (in August 2005).

Ticks, questing for hosts, were collected by flagging method. A white linen cloth, 135 x 110cm, attached to a stick, was used. Each collection session lasted for 2 hours (one person collected two hours, two persons collected one hour each etc.), with an overall sampling effort of 12,240 min of tick collections. Ticks were collected between 11.00 a.m. and 5 p.m. Ticks attached to linen cloth were collected using exhauster and stored afterwards in vials containing 70% ethanol. Species determination was

carried out with the use of taxonomic key (Trilar, unpublished).

The material is stored in Study collection of ticks (PMSL-Ixodida) housed in Slovenian Museum of Natural History.

2.3 Climatic data

Climatic data were recorded in local climatological station Lendava. Data were kindly provided by the Environment Agency of the Republic of Slovenia. We obtained also data on site-sampling day (temperature in the shadow, sun and soil).

2.4 Data visualization and analysis

Data was stored in Excel.xlsx files and imported into R (R Core Team, 2015) for further analysis. Figures were done using ggplot2 (Wickham 2009). Modeling was explored using base R functions and lme4 (Bates et al. 2015) package. Data manipulation was handled by packages readxl and tidyr. Modeling approach, while not described here, is part of a reproducible supplemental material generated using package knitr (Xie 2015).

3. Results and discussion

There are 16 tick species (Acarina: Ixodida) distributed across Slovenia (Tovornik 1987a, b, 1988a, b, c, 1989, 1990, 1991, Trilar 2004), with *D. reticulatus* among them.

The occurrence of *D. reticulatus* on the territory of Slovenia was not described before. By extensive 3.5 year sampling period, we obtained sufficient data allowing for the first time to clearly define the distribution rate and seasonal activity of adult *D. reticulatus* in this part of Europe, north-east Slovenia.

From November 2003 till May 2007 were with flagging method collected altogether 2511, exclusively adult stages of *D. reticulatus*, among them 2164 in Muriša, 324 in Murska šuma and 23 in Dolinski pašnik area. The absence of immature life stages of *D. reticulatus* in samples obtained by flagging is usual observation (Široký et al. 2011, Földvári et al. 2016). Nymphs and larvae generally parasitize on Insectivora and Rodentia, occasionally on Aves (Baker 1999) and probably also living in host's burrows, protected from unfavourable climate (Meyer-König et al. 2001). Therefore, the presence of these developmental stages should be checked also herein.

The seasonal activity of adult *D. reticulatus* has been extensively studied in Europe and although the abundance and dynamics of these ticks vary, two activity peaks have been reported: in spring and autumn (Razumova 1988, Martinod and Gilot 1991, Széll et al. 2006, Bartosik et al. 2011, Buczek et al. 2014, Földvári et al. 2016). Also our field study showed a bimodal pattern of activity of this species. The highest activity peaks were noted in the spring, culminating in February-April/May, peaking in average in March and with considerably lower rate (3-8-times) in the second activity peak in autumn, culminating in the end of August/September-November. The greatest number of adults in autumn was collected in October or November (Figure 1).

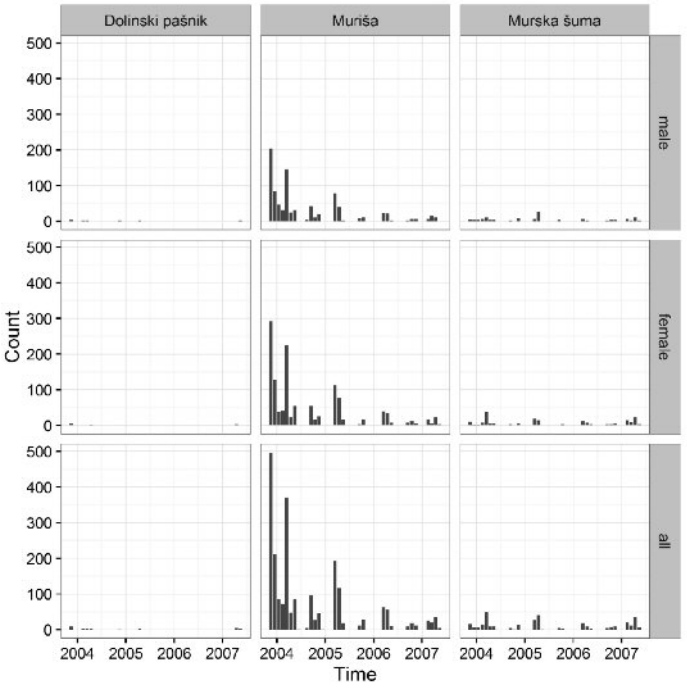

Fig. 1: Count of collected individuals for individual locations (columns) per sex (rows). Bottom row represents total count.

Abundance of *D. reticulatus* varied markedly between localities in interval 23-2164. It was most abundant in zones along rivers Mura and Ledava. The highest quantity of ticks was recorded in meadows near Muriša, oxbow lake of the river Mura, where 6.6-times more ticks were caught than in swampy forest area Murska šuma, which was occasionally flooded after huge rainfall and even 94-times more than in Dolinski pašnik. Meadows, deciduous forest and swampy mixed woods placed near water bodies or large stagnant waters are typical habitats of *D. reticulatus*. The most important factor for occurrence of this tick species is a combination of a high level ground water, along with drying soil (Karbowiak 2014). These habitats are in north-east Slovenia probably representing a suitable habitat for hosts of *D. reticulatus*. On the other hand, there are studies of quite abundant distribution of this tick species even in shrubby ecotones, much far from the rivers (Široký et al. 2011) or on higher hills (up to an altitude of 1000 m a.s.l.) (Hornok and Farkas 2009) which speaks also for the relative importance of host availability.

In subsequent years of sampling the abundance of ticks was decreasing, especially in localities Muriša and Dolinski pašnik (Figure 1). For instance, in locality Muriša was in late autumn 2003 (November, December) noted the highest activity peak of *D. reticulatus* in spring or autumn in the all 3.5 year collection period (altogether with 708 individuals which represented 28% of all collected ticks in all localities). In late autumn 2004 was in the same locality caught 661 ticks less than in previous year (Figure 1). We believe that the reason was not due to temperature. Temperatures

(measured in shadow) were on the day of sampling in November/December 2003 and in November/December 2004; 6.6/3.6ºC and 13.1/3.2ºC, respectively, which is in the range of *D. reticulatus* activity (Bartosik et al. 2011, Buczek et al. 2014). We think that decrease could be explained either by oversampling of ticks or by changes in habitat. At Muriša the use of arable land started to increase and surrounding vegetation by oxbow lake has frequently been removed presumably by fishermen. In Dolinski pašnik 70% (16 of 23) of all ticks were collected in year 2003-2004 (Figure 1). The main causes could be due to habitat degradation. Part of the locality Dolinski pašnik was already dedicated to football field, furthermore in the year 2006 nearby started construction works for the highway. A problem could be also abandonment of grazing cattle in Dolinski pašnik, thereby reducing the number of potential tick hosts. It is also possible that our 3.5-year sampling period contributed to every year reduction of the numbers of this tick species in sampling areas. Finally, decreasing amount of ticks in both sampling localities could be also due to longer snow cover in late autumn-winter 04/05 and 05/06.

Dermacentor reticulatus is a psychrophilic tick and is very tolerant to low temperatures (Hubálek et al. 2003). The lower thermal threshold of activity of adult *D. reticulatus* is at air/soil temperatures 0.7/-0.1ºC (Buczek et al. 2014). Its activity starts after disappearance of snow cover at 2-4ºC and can be found active in January and February (Karbowiak 2014). The highest activity of adult *D. reticulatus* at daily mean temperatures is ranging from 4-13ºC (Bartosik et al. 2011). During a 24-hour monitoring in Wales the minimum temperature at which *D. reticulatus* were recorded active was 3.3ºC and the minimum overnight temperature was -5.4ºC (Földvári et al. 2016). The upper range of the threshold temperature for tick activity is 39ºC (Bartosik et al. 2011). Warmer and humid conditions are preferred for its development and reproduction (Zähler et al. 1996). The present investigation confirmed the activity of adult *D. reticulatus* throughout winter months (January and February) in Muriša and Murska šuma in year 2004, at daily temperatures (measured in shadow) ranging from 5-11.2°C. Mean monthly air/soil temperatures for January and February 2004 were -1.0/-0.4ºC and 2.5/-0.1ºC, respectively (data from the Slovenian Environmental Agency, Climatological station Lendava). In winter months was altogether caught 177 specimens, with 157 in Murska šuma. The winter occurrence of *D. reticulatus* was not reported later during the field study, which may be attributed to weather conditions, e.g. longer persistence of snow cover. The mean temperatures and hours of sunshine in winter months did not differ over the sampling years. Difference in the number of days of persistence of snow cover was noted, namely, in winter months 2004 with 9 days, 2005 (28 days), 2006 (32 days) and 2007 (4 days) (data from the Slovenian Environmental Agency). Most of the ticks (89.2%) were collected when the mean daily temperatures were ranging from 0 to 14.9ºC. In particular, 91 (3.6%) were collected with temperatures at ≤0ºC, 1029 (41%) at 0.5-4.9ºC, 676 (27%) at 5-9.9ºC, 535 (21.2%) at 10-14.9ºC, 175 (7%) at 15-19.9ºC, and 5 (0.2%) at ≥20ºC. *Dermacentor reticulatus* was not active during the summer months.

The sex ratio (Figure 2) is an important parameter, which characterizes the state and dynamics of natural populations of animals. Most ixodid tick species can be characterized

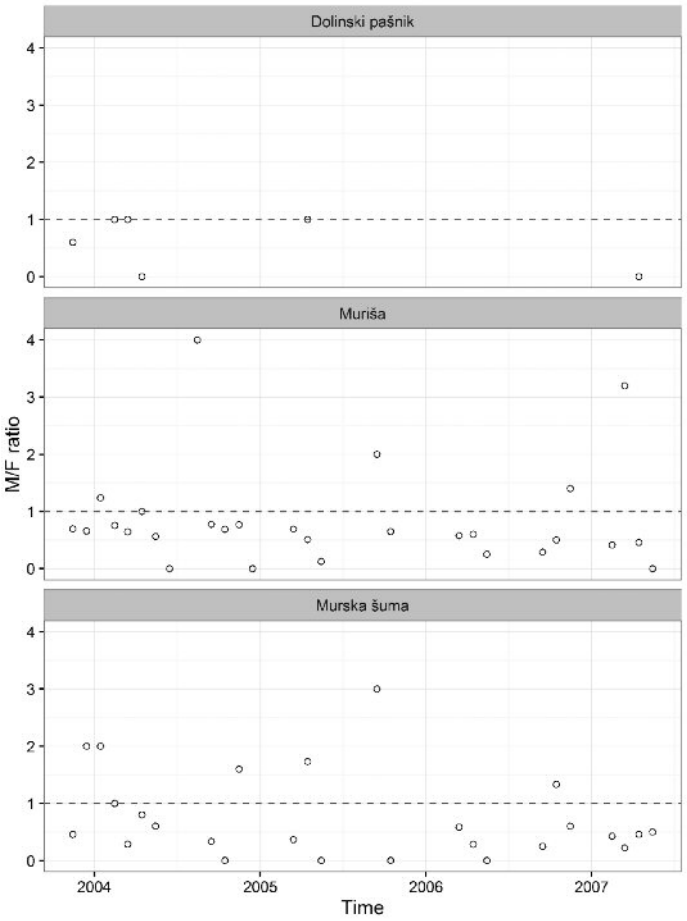

Fig. 2: Sex ratio per individual collection for different locations. Some ratios are not represented by a real number because only one sex was found.

by a 1:1 sex ratio of their progeny with biased sex ratios later in adult stage (Fourie et al. 1996). We recorded female-biased sex ratio throughout the years in all sampling localities, namely for Muriša 59.5% (1287 of 2164), Murska šuma 62.7% (203 of 324) and Dolinski pašnik 60.8% (14 of 23). Higher proportion of females were obtained also in studies, e.g. Široký et al. 2011 (in Czech Republic); Hornok 2009, Hornok and Farkas 2009 (in Hungary); Buczek et al. 2014, Nowak 2011 (in Poland), Krčmar et al. 2014a (in Croatia), among others. Female-biased sex ratio in field samples of *D. reticulatus* may be influenced by mating strategies (Fourie et al. 1996). Metastriate ticks, including *Dermacentor* spp., mate exclusively on their hosts (Kiszewski et al. 2001). Bartosik et al. (2011) reported that *D. reticulatus* males remain on the host longer than females, which may explain their lower numbers found on vegetation. Besides that, females need to find a host for ingestion of blood, essential for egg development, which increase their questing. Consequently, males are less likely to be found by cloth-dragging (Fourie et al. 1996). Prevalence rates may be affected also by different capa-

bilities of the sexes to survive unfavourable conditions, e.g. *D. reticulatus* females were found to be more resistant to dehydration than males (Meyer-König et al. 2001), which may be another reason why *D. reticulatus* females quest more.

Dermacentor reticulatus are expanding their habitats and changing the spatial distribution as they occur at far more sites than previously known (Karbowiak 2014, Földvári et al. 2016). To Slovenia the closest data of occurrence of this species are from Hungary, where is *D. reticulatus* the second most common tick species (Sréter et al. 2005). In south western part of Hungary (close to the Slovenian-Hungarian border) were found only in places with partly dry vegetation, and up to an altitude of 900–1000m a.s.l. (Hornok and Farkas 2009), while in north eastern Slovenia at altitude 160m a.s.l. and in swampy mixed woods placed near water bodies or large stagnant waters. We assume that our findings point to an enlargement of Hungarian distribution area of the species, as well as Krčmar et al. (2014) and their findings of it in Croatian part of Baranja region (Figure 3). The expansion of *D. reticulatus* to new and previously uninhabited areas has been observed in Europe (Karbowiak 2014, Földvári et al. 2016). A range of factors could be responsible for the changes in the

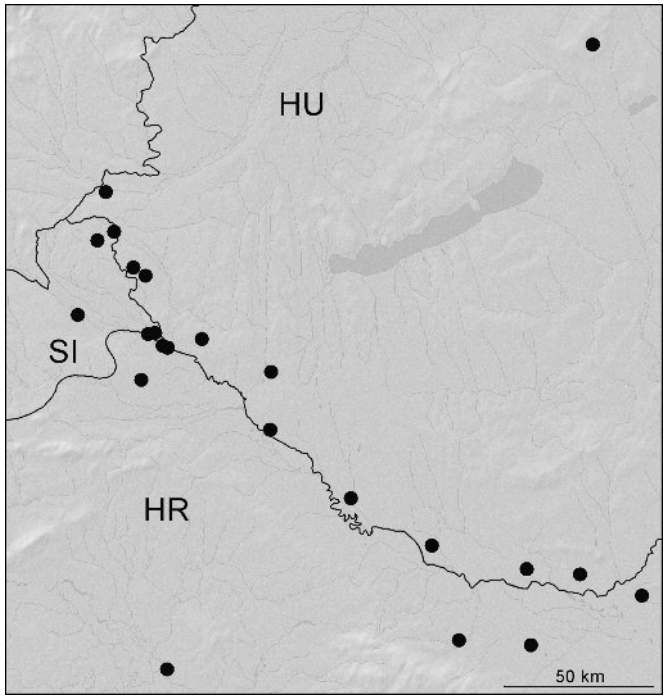

Fig. 3: Collection sites of *Dermacentor reticulatus* at the south western edge of Pannonian lowland. The data are taken from this work and from literature (Vesenjak-Hirjan and Šooš 1976, Borčić et al. 1978, Hornok and Farkas 2009, Dobec et al. 2009, Krčmar 2012, Krčmar et al. 2014). The map is created by GPS Visualizer (Schneider 2003-2014)

distribution of this tick species, including global warming (Gray et al. 2009), the shifting use of landscape (e.g. reduction of the use of pesticide and other chemicals, reforestation) (Bullová et al. 2009), the transformation of ploughed land into areas covered with permanent vegetation (Heile et al. 2006), the increase of numbers of wild animals (as a result of nature conservation), the introduction of ticks into new regions through tourism, transport (Sréter et al. 2005, Karbowiak 2014), as well as the relationship between the occurrence of *D. reticulatus* and the habitats of their important hosts (Nowak 2011) and also other unknown factors.

Conclusions

Studying tick ecology is essential step towards a better understanding of the transmission dynamics and the risk these arthropods pose to animal and human populations. *Dermacentor reticulatus* tick is a vector and final host of *B. c. canis*, recently expanding in central Europe (Duh et al. 2004, 2006, Földvári et al. 2007, Leschnik et al. 2008, Adaszek et al. 2011, Kubelová et al. 2011). Expansion of *D. reticulatus* might be followed by an expansion of tick-borne diseases (Kiewra and Czulowska 2013, Földvári et al. 2016). The confirmed occurrence of *D. reticulatus* in north-eastern Slovenia provided evidence that this species has extended its range. It indicates a need of future systematic sampling to assess a speed of expansion as well as infection rate of this tick species.

Acknowledgements

We would like to thank Martina Ploj for her partial elaboration of raw field data and support during the fieldwork. Thanks also to others who joined field work. Data for *D. reticulatus* distribution in Hungary (localities with coordinate) were kindly provided by dr. Sándor Hornok. Climatic data were supplied by Environmental Agency of the Republic of Slovenia.

The research was part of the program "Communities, relations and communications in the ecosystems" (No. P1-0255) financed by Ministry of Higher Education, Science and Technology of the Republic of Slovenia.

References

Adaszek Ł., Carbonero Martinez A., Winiarczuk S., 2011. The factors affecting the distribution of babesiosis in dogs in Poland. – *Veterinary Parasitology* **181**: 160-165.

Baker A.S., 1999. *Mites and ticks of domestic animals – an identification guide and information source*. – London, The Natural History Museum, 240 pp.

Barker S.C., Murrell A., 2008. *Systematic and evolution of ticks with a list of valid genus and species names*. – In: Bowman A.S., Nuttal P.A. (Eds). Ticks, biology and control. – Cambridge University Press, Cambridge, pp. 1-39.

Bartosik K., Wisniowski L., Buczek A., 2011. Abundance and seasonal activity of adult *Dermacentor reticulatus* (Acari: Amblyommidae) in eastern Poland in relation to meteorological conditions and the photoperiod. – *Annals of Agricultural and Environmental Medicine* **18**: 340-344.

Bates D., Maechler M., Bolker B., Walker S., 2015. Fitting Linear Mixed-Effects Models Using lme4. – *Journal of Statistical Software* **67**(1): 1-48. doi:10.18637/jss.v067.i01.

Borčić B., Aleraj B., Žutić M., Mikačić D., 1978. Uloga krpelja (Ixodidae) u podržavanju prirodnog žarišta tularemije u srednjoj Posavini. – *Veterinarski arhiv* **48**: 277-283.

Buczek A., Bartosik K., Zajac Z., 2014. Changes in the activity of adult stages of *Dermacentor reticulatus* (Ixodida: Amblyommidae) induced by weather factors in Eastern Poland. – *Parasites & Vectors* **7**: 245., doi:10.1186/1756-3305-7-245

Bullová E., Lukán M., Stanko M., Petko B., 2009. Spatial distribution of *Dermacentor reticulatus* tick in Slovakia in the beginning of the 21st century. – *Veterinary Parasitology* **165**: 357-360.

Cochez C., Lempereur L., Madder M., Claerebout E., Simons L., De Wilde N., Linden A., Saegerman C., Heyman P., Losson B., 2012. Foci report on indigenous *Dermacentor reticulatus* populations in Belgium and a preliminary study of associated babesiosis pathogens. – *Medical and Veterinary Entomology* **26**: 355-358.

Dautel H., Dippel C., Oehme R., Hartelt K., Schettler E., 2006. Evidence for an increased geographical distribution of *Dermacentor reticulatus* in Germany and detection of *Rickettsia* sp. RpA4. – *International Journal of Medical Microbiology* **296** (S1): 149–156.

Dobec M., Golubić D., Punda-Polić V., Kaeppeli F., Sievers M., 2009. *Rickettsia helvetica* in *Dermacentor reticulatus* ticks. – *Emerging Infectious Disease* **15**: 98-100.

Duh D., Tozon N., Petrovec M., Strašek K., Avšič-Županc T., 2004. Canine babesiosis in Slovenia: Molecular evidence of *Babesia canis canis* and *Babesia canis vogeli*. – *Veterinary Research* **35**: 363–368.

Duh D., Slovak M., Saksida A., Strašek K., Petrovec M., Avšič-Županc T., 2006. Molecular detection of *Babesia canis* in *Dermacentor reticulatus* ticks collected in Slovakia. – *Biologia (Bratislava)* **61**: 231-233.

Földvári G., Márialigeti M., Slymosi N., Lukács Z., Majoros G., Kósa J.P., Farkas R., 2007. Hard ticks infesting dogs in Hungary and their infection with *Babesia* and *Borrelia* species. – *Parasitology Research* **101**: 25-34.

Földvári G., Široký P., Szekeres S., Majoros G., Sprang H., 2016. *Dermacentor reticulatus*: a vector on the rise. – *Parasites & Vectors* **9**: 314., doi 10.1186/s13071-016-1599-x.

Fourier L.J., Belozerov V.N., Kok D.J., 1996. Sex ratio characteristics in *Ixodes rubicundus* (Acari: Ixodidae), the Karoo paralysis tick. – *Experimental and Applied Acarology* **20**(8): 477-481.

Gogala A. (Ed.), 2002. *Mura in Prekmurje*. – Prirodoslovni muzej Slovenije, Ljubljana, 88 pp.

Gray J.S., Dautel H., Estrada-Peña A., Kahl O., Lindgren E., 2009. Effects of climate change on ticks and tick-borne diseases in Europe. – *Interdisciplinary Perspectives on Infectious Diseases*. doi: 10.1155/2009/593232

Heile C., Heydorn A.O., Schein E., 2006. *Dermacentor reticulatus* (Fabricius, 1794), biology and vector for *Babesia canis* in Germany. – *Medical and Veterinary Entomology Berliner und Münchener tierärztliche Wochenschrift* **119**: 330-334.

Hornok S., 2009. Allochronic seasonal peak activities of *Dermacentor* and *Haemaphysalis* spp. under continental climate in Hungary. – *Veterinary Parasitology* **163**: 366-369.

Hornok S., Farkas R., 2009. Influence of biotope on the distribution and peak activity of questing ixodid ticks in Hungary. – *Medical and Veterinary Entomology* **23**: 41-46.

Hubálek Z., Treml F., Halouzka J., Juricová Z., Hunady M., Janik V., 1996. Frequent isolation of *Francisella tularensis* from *Dermacentor reticulatus* ticks in an enzootic focus of tularemia. – *Medical and Veterinary Entomology* **10**(3): 241-246.

Hubálek Z., Sixl W., Halouzka J., 1998. *Francisella tularensis* in *Dermacentor reticulatus* ticks from the Czech Republic and Austria. – *Wien. Klin. Wochenschr.* **110**(24): 909-910.

Hubálek Z., Halouzka J., Juricová Z., 2003. Host-seeking activity of ixodid ticks in relation to weather variables. – *Journal of Vector Ecology* **28**(2): 159-165.

Karbowiak G., 2014. The occurrence of the *Dermacentor reticulatus* tick – its expansion to new areas and possible causes. – *Annals of Parasitology* **60**(1): 37-47.

Kiewra D., Czulowska A., 2013. Evidence for an increased distribution range of *Dermacentor reticulatus* in south-west Poland. – *Experimental and Applied Acarology* **59**: 501-506.

Kiszewski A.E., Matuschka F-R., Spielman A., 2001. Mating strategies and spermiogenesis. – *Annual Review of Entomology* **46**: 167-182.

Krčmar S., 2012. Hard ticks (Acari, Ixodidae) of Croatia. – *ZooKeys* **234**: 19-57., doi: 10.3897/zookeys.234.3658.

Krčmar S., Vereš M., Trilar T., 2014. Fauna of hard ticks (Acari: Ixodidae) in different habitats in Croatian part of Baranja – *Šumarski list* **5-6**: 309-314.

Kubelová M., Tkadlec E., Bednář M., Roubalová E., Široký P., 2011. West-to-east differences of *Babesia canis canis* prevalence in *Dermacentor reticulatus* ticks in Slovakia. – *Veterinary Parasitology* **180**: 191-196.

Leschnik M., Kirtz G., Tichy A., Leidinger E., 2008. Seasonal occurence of canine babesiosis is influenced by local conditions. – *International Journal of Medical Microbiology* **298**(S1): 243-248.

Lobetti R.G., 1998. Canine babesiosis. Compend. – *Cont. Educ. Pract. Vet.* **20**: 418-431.

Martinod S., Gilot B., 1991. Epidemiology of canine babesiosis in relation to the activity of *Dermacentor reticulatus* in southern Jura (France). – *Experimental and Applied Acarology* **11**: 215-222.

Meyer-König A., Zähler M., Gothe R., 2001. Studies on the critical water mass and the rehydration potential of unfed adult *Dermacentor marginatus* and *Dermacentor reticulatus* ticks (Acari: Ixodidae). – *Experimental and Applied Acarology* **25**: 505-516.

Mršić N., 1997. *Biotska raznovrstnost v Sloveniji: Slovenija – "vroča točka" Evrope*. – Ministrstvo za okolje in prostor, Uprava RS za varstvo narave, Ljubljana, 129 pp.

Nowak M., 2011. Discovery of *Dermacentor reticulatus* (Acari: Amblyommidae) populations in the Lubuskie Province (Western Poland). – *Experimental and Applied Acarology* **54**: 191-197.

Parola P., Paddock C.D., Raoult D., 2005. Tick-borne rickettsioses around the world: emerging diseases challenging old concepts. – *Clinical Microbiology Reviews* **18**: 719-756.

R Core Team, 2015. R: A language and environment for statistical computing. – *R Foundation for Statistical Computing, Austria*. URL https://www.R-project.org/.

Razumova I.V., 1988. The activity of *Dermacentor reticulatus* Fabr. (Ixodidae) ticks in nature. – *Meditsinskaia Parazitologiia (Moskow)* **4**: 8-14.

Řehaček J., Urvölgyi J., Kocianová E., Sekeyová Z., Vavreková M., Kovácová E., 1991. Extensive examination of different tick species for the infestation with *Coxiella burnetii* in Slovakia. – *European Journal of Epidemiology* **7**(3): 299-303.

Rubel F., Brugger K., Pfeffer M., Chitimia-Dobler L., Didyk Y.M., Leverenz S., Dautel H., Kahl O., 2016. Geographical distribution of *Dermacentor marginatus* and *Dermacentor reticulatus* in Europe. – *Ticks and Tick-borne Diseases* **7**: 224 - 233

Schneider A., 2003-2014: *GPS Visualizer*. – http://www.gpsvisualizer.com, 11. 11. 2014.

Skoberne P., 1988. *Sto naravnih znamenitosti Slovenije*. – Prešernova družba, Ljubljana, 100 pp.

Sréter T., Széll Z., Varga I., 2005. Spatial distribution of *Dermacentor reticulatus* and *Ixodes ricinus* in Hungary: evidence for change? – *Veterinary Parasitology* **128**: 347-351.

Széll Z., Streter-Lancz Z., Mariáligeti K., Streter T., 2006. Temporal distribution of *Ixodes ricinus*, *Dermacentor reticulatus* and *Haemaphysalis concinna* in Hungary. – *Veterinary Parasitology* **141**: 377-379.

Široký P., Kubelová M., Bednár M., Modrý D., Hubálek Z., Tkadlec E., 2011. The distribution and spreading pattern of *Dermacentor reticulatus* over its threshold area in the Czech Republic – How much is range of this vector expanding? – *Veterinary Parasitology* **183**: 130-135.

Tovornik D., 1987a. On the Bionomics of the *Ixodes (Pholeoixodes) hexagonus* Leach, 1815 in Slovenia (Yugoslavia). – *Biološki vestnik* **35**(1): 101-120.

Tovornik D., 1987b. Morfološke značilnosti dveh pripadnikov podrodu *Pholeoixodes* Schulze, 1942: *Ixodes hexagonus* Leach in *Ixodes canisuga* Johnston. – *Biološki vestnik* **35**(2): 125-134.

Tovornik D., 1988a. Geographic distribution and other population parameters of *Ixodes (Exopalpiger) trianguliceps* (Birula, 1895) in Yugoslavia. – *Biološki vestnik* **36**(1): 33-54.

Tovornik D., 1988b. A revision of ticks belonging to the *Rhipicephalus sanguineus* complex (Latreille) collected in Yugoslavia coastal region. – *Biološki vestnik* **36**(4): 77-84.

Tovornik D., 1988c. The significance of the roe-deer (*Capreolus capreolus* Linne, 1758) as the host and disseminators of ixodid ticks in SR Slovenia (Yugoslavia). – *Biološki vestnik* **36**(4): 85-94.

Tovornik D., 1989. Red squirrel (*Sciurus vulgaris* Linne, 1758) and fat dormouse (*Glis glis* Linne, 1766) as host of ixodid ticks in Slovenia (Yugoslavia). – *Biološki vestnik* **37**(2): 83-96.

Tovornik D., 1990. The significance of the birds (Aves) as the host and disseminators of ixodid ticks (Yugoslavia). – *Biološki vestnik* **38**(2): 77-108.

Tovornik D., 1991. Podatki o klopih *Ixodes frontalis* (Panzer, 1798) in *Ixodes arboricola* Sculze et Schlottke, 1929, najdenih na ptičih v Jugoslaviji. – *Biološki vestnik* **39**(1/2): 157-164.

Trilar T., 2004. Ticks (Acarina: Ixodidae) on birds in Slovenia. – *Acrocephalus* **25**(123): 213 – 216.

Uilenberg G., Franssen F.F., Perié N.M., Spanjer A.A., 1989. Three groups of *Babesia canis* distinguished and a proposal for nomenclature. – *Veterinary Quarterly* **11**: 33-40.

Vesenjak-Hirjan J., Šooš E., 1976. *The role of migrating sheep in dissemination of tick-borne encephalitis virus*. – In: Vesenjak-Hirjan J., (Ed.), Tick-borne encephalitis in Croatia (Yugoslavia). – Zagreb, Rad JAZU 372: 167–172.

Xie Y., 2015. *Dynamic Documents with R and knitr*. – 2nd edition. Chapman and Hall/CRC. ISBN 978-1498716963.

Wickham H., 2009. *ggplot2: Elegant Graphics for Data Analysis*. – Springer-Verlag New York.

Wickham H., 2016. *readxl: Read Excel Files*. – R package version 0.1.0.9000.

Wickham H., 2015. *tidyr: Easily Tidy Data with `spread()` and `gather()` Functions.* – R package version 0.3.1. https://CRAN.R-project.org/package=tidyr

Zähler M., Gothe R., 1995. Effect of temperature and humidity on longevity of unfed adults and on oviposition of engorged females of *Dermacentor reticulatus* (Ixodidae). – *Applied parasitology* **36**(3): 200-211.

Received / Prejeto: 9. 3. 2017

ACTA ENTOMOLOGICA SLOVENICA

LJUBLJANA, JUNIJ 2017 Vol. 25, št. 1: 89–114

FAUNISTIC RESULTS FROM THE 5TH BALKAN ODONATOLOGICAL MEETING – BOOM 2015, REPUBLIC OF MACEDONIA

Damjan VINKO[1], Dejan KULIJER[2], Despina DINOVA[3], Biljana RIMČESKA[4], Oliver BRAUNER[5] & Marko OLIAS[6]

[1] Slovene Dragonfly Society, Verovškova 56, SI-1000 Ljubljana, Slovenia; e-mail: damjan.vinko@gmail.com
[2] National Museum of Bosnia and Herzegovina, Zmaja od Bosne 3, 71000 Sarajevo, Bosnia and Herzegovina; e-mail: dejan.kulijer@gmail.com
[3] Macedonian Ecological Society, Blvd. Boris Trajkovski Str. 9-7a, Skopje, Macedonia; e-mail: despinadi@gmail.com
[4] Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 2 Gagarin Street, 1113-Sofia, Bulgaria; e-mail: rimceska@gmail.com
[5] Büro für Zoologie, Vegetation und Naturschutz, Rudolf-Breitscheid-Straße 62, D-16225 Eberswalde, Germany; e-mail: oliver.brauner@gmail.com
[6] Naturschutzinstitut Freiberg, Bernhard-Kellermann-Straße 20, D-09599 Freiberg, Germany; e-mail: markoolias@aol.com

Abstract – Dragonfly research in the West Balkans experienced significant boost in recent years, also due to the establishment of the Balkan OdonatOlogical Meetings (BOOM) in 2011. The main goal of BOOM is to contribute to research and protection of dragonflies of the Balkan Peninsula. This paper presents the faunistic results of the 5th BOOM, held in Republic of Macedonia. Between 7 and 15 August 2015, 46 sites were surveyed and 41 dragonfly species found. This represents more than half of the hitherto recorded dragonfly species for the country. This paper includes data for localities and habitats from central and southern part of R. Macedonia, which was less investigated in the past. Significant results include the first documented report of *Selysiothemis nigra* for the country. New data on several species with a comparably low number of previously published records for R. Macedonia, i.e. *Chalcolestes parvidens*, *Caliaeschna microstigma*, *Lindenia tetraphylla*, *Cordulegaster heros*, *C. bidentata*, *C. insignis*, *Somatochlora meridionalis*, *S. flavomaculata*, *Sympetrum vulgatum* and *S. flaveolum*, are also presented and brief discussion is provided.

KEY WORDS: dragonflies, Odonata, distribution, R. Macedonia, Balkan, BOOM, *Selysiothemis nigra*, first records

Izvleček – FAVNISTIČNI REZULTATI 5. MEDNARODNEGA SREČANJA ODONATOLOGOV BALKANA – BOOM 2015, REPUBLIKA MAKEDONIJA

Raziskovanje kačjih pastirjev je na zahodnem Balkanu v zadnjih letih doživelo velik napredek. Slednje je tudi rezultat vzpostavitve širšega balkanskega odonatološkega sodelovanja v okviru Mednarodnih srečanj odonatologov Balkana (BOOM), ki potekajo od leta 2011 dalje. Glavni cilj srečanj je prispevati k raziskavam in varstvu kačjih pastirjev balkanskega polotoka. Ta prispevek predstavlja favnistične rezultate 5. BOOM, ki je potekal v Republiki Makedoniji. Na 46 pregledanih lokalitetah smo med 7. in 15. avgustom 2015 popisali 41 vrst kačjih pastirjev, kar je več kot polovica vseh znanih vrst kačjih pastirjev Republike Makedonije. Članek vključuje podatke za lokalitete in habitate osrednjega in južnega dela države, ki je bil v preteklosti slabo raziskan. Pomembnejši rezultati vključujejo prvo dokumentirano poročanje o pojavljanju temnega slaniščarja (*Selysiothemis nigra*) za državo. Zabeležena so tudi nova nahajališča v R. Makedoniji redkih vrst kačjih pastirjev. Ti so: presenetljiva pazverca (*Chalcolestes parvidens*), bledi vetrnjak (*Caliaeschna microstigma*), velika peščenka (*Lindenia tetraphylla*), veliki, povirni in modrooki studenčar (*Cordulegaster heros*, *C. bidentata*, C. *insignis*), sredozemski in pegasti lesketnik (*Somatochlora meridionalis, S. flavomaculata*) ter navadni in rumeni kamenjak (*Sympetrum vulgatum, S. flaveolum*).

KLJUČNE BESEDE: kačji pastirji, Odonata, razširjenost, Republika Makedonija, Balkan, BOOM, *Selysiothemis nigra*, prvi podatki

Introduction

Interest in dragonflies (Insecta: Odonata) is increasing in all countries of the West Balkan Peninsula in recent years. The result is the establishment of the Balkan OdonatOlogical Meeting, or BOOM in 2011 (Jović 2011) with the main goal of further development of odonatology in the Balkans. The main concept of BOOM is to yearly gather odonatologists in a different Balkan country. With focus on fieldwork, BOOM gives the opportunity of gaining experience in dragonfly identification and to gather new data on dragonfly distribution in selected areas (Vinko 2011a). Annual BOOM Meeting quickly became a recognized event, where dragonfly enthusiasts – professional and amateur – can meet, exchange their ideas, present their research and work together in investigating dragonflies in one of the least known regions of Europe (Vinko et al. 2012). New regional cooperation and joint research resulted in several papers on dragonfly fauna of the region (Šácha & Bedjanič 2011, Vinko 2011b, Vinko & Vilenica 2013, Rajkov et al. 2015, Kulijer et al. 2016, Vinko et al. 2016).

The 5th Balkan OdonatOlogical Meeting (BOOM 2015 – R. Macedonia) was organized by the Biology Students' Research Association Skopje (Skopje, R. Macedonia), Macedonian Ecological Society (Skopje, R. Macedonia) and the Slovene Dragonfly

Society (Ljubljana, Slovenia) in the beginning of August 2015 in R. Macedonia. A total of 16 participants from Slovenia, Serbia, Bosnia and Herzegovina, R. Macedonia, and from Germany and the Netherlands took part in this Meeting. Local media also covered the Meeting (Darudova 2015a, 2015b).

Dragonflies of the Republic of Macedonia are still insufficiently studied, although good progress has been made in recent years. In R. Macedonia, only the dragonfly fauna of lakes Dojran, Prespa and Ohrid with their surroundings is better known and reported. The most comprehensive older works include Filevska (1954), Buchholz (1963), Karaman (1969, 1972, 1979, 1981, 1984–85), Peters & Hackethal (1986) and Adamović (1990). Though numerous papers with dragonfly records from the country have been published over the past decade, most of them include small number of records or cover only a small portion of the country (Boshamer et al. 2006, Kitanova et al. 2008, 2013, Micevski et al. 2008, Bedjanič et al. 2008, Melovski et al. 2008, Smiljkov et al. 2008, Jović 2009, Jović & Mihajlova 2009, Zawal et al. 2010, Bedjanič & Vinko 2012, Holuša & Holušova 2012, Holuša & Krivan 2012, Vinko 2012, Krpač et al. 2013, Kovacs & Muranyi 2013). The knowledge on individual species distribution has numerous gaps and is still far from being sufficient, not to mention the lack in the knowledge of group's biology, ecology or nature conservation aspects.

For R. Macedonia, Hristovski et al. (2015) gives a checklist of 64 dragonfly species, where also unpublished records for *Selysiothemis nigra* (Vander Linden 1825) are included (Dinova pers. comm.). Critical review of National list of dragonfly species is in preparation (Dinova & Jović pers. comm.). Protection of the Odonata fauna in R. Macedonia has received little attention and no national Red list exist (Kitanova 2015). In Macedonian language, odonates are called *Vilinski Konjčinja*.

Materials and methods

Odonates were surveyed between 7 and 15 August 2015. The weather during the study was sunny, mostly with high temperatures up to 40°C and without wind. In general, the weather was very favourable for dragonflies.

Data were collected mainly in the central and southern part of R. Macedonia. The selection of localities was based on the possibility to find the most interesting species, and to present the diversity of species and habitats of the West Balkans and – with it – R. Macedonia. Within R. Macedonia the aim was to cover the least investigated central part of the country. In total, 46 localities were visited (Fig. 1). Both lotic and lentic waters were investigated, as rivers, lakes and their confluences, as well as artificial habitats: fishponds, gravel pits, dams etc. Dragonfly fauna of some sites was investigated for the first time. We used standard odonatological field work methods, including visual observation and determination, catching specimens with a net, photographing etc. We searched for imagines (adults) as well as exuviae at all sites. Imagines were identified on site, without collecting voucher samples. Identification of exuviae was mostly done by the co-authors O. Brauner and M. Olias. Sampling for larvae was done mostly on rivers and streams and only occasionally on lentic waters.

Fig. 1: Geographical position of investigated localities during the fifth Balkan OdonatOlogical Meeting (BOOM 2015) in the Republic of Macedonia. The numbers correspond to the list of localities in the Materials and methods section.

During the survey, a special effort was given to confirm the presence of few enigmatic stream-dwelling species for which recent records are lacking and are most probably under-recorded: *Epallage fatime* (Charpentier 1840), *Caliaeschna microstigma* (Schneider 1845), *Cordulegaster heros* Theischinger 1979, *Cordulegaster bidentata* Sélys 1843, *Cordulegaster insignis* Schneider 1845 and *Somatochlora meridionalis* Nielsen 1935.

Abbreviation used: L – site (locality).

List of the localities investigated during the 5th Balkan OdonatOlogical Meeting (BOOM 2015):

For each locality, geographical coordinates, altitudes and survey dates are given. For localities 28 and 30, only approximate coordinates are given. The localities are arranged in chronological order.

1. Kavadarci, Kavadarci: Student dorm in Kavadarci; 41.44083, 22.02000; 255 m; 7.8.2015.

2. Kavadarci, Mokliš̌ta: Mokliš̌ta Lake (= hydroaccumulation on Luda Mara River); 41.39167, 22.03778; 290 m; 8.8.2015.
3. Kavadarci, Bojančiš̌te: Done Popov Lake (= Vitačevo Reservoir); 41.264385, 22.055104; 920 m; 8.8.2015.
4. Demir Kapija, Demirkapiska Klisura: stream, a confluence of a stream and Vardar River in Demirkapiska Klisura Gorge; 41.405822, 22.259998; 140 m; 8.8.2015.
5. Demir Kapija, Demirkapiska Klisura: small reservoir at Demirkapiska Klisura Gorge after the tunnels; 41.405621, 22.267166; 110 m; 8.8.2015.
6. Demir Kapija, Demir Kapija: Bošava River; 41.405883, 22.242399; 115 m; 8.8.2015.
7. Demir Kapija, Demirkapiska Klisura: stream flowing into Vardar River, north from Klisura – dry at this survey; 41.402209, 22.295031; 95 m; 8.8.2015.
8. Negotino, Dubrovo: swamp between Staro Dubrovo and Bučeto south-east from Negotino; 41.475293, 22.125612; 165 m; 8.8.2015.
9. Gevgelija, Miletkovo: Petruška Reka River; 41.290452, 22.465181; 90 m; 9.8.2015.
10. Gevgelija, Negorci: Negorski Banji; 41.172987, 22.490815; 65 m; 9.8.2015.
11. Bogdanci, Bogdanci: Luda Mara River between Gorni Bolovan and Dolni Bolovan (flowing into Paljurci Lake); 41.210830, 22.630261; 145 m; 9.8.2015.
12. Dojran, Crnićani: Luda Mara River with a dam; 41.236280, 22.636784; 175 m; 9.8.2015.
13. Dojran, Crnićani: fishponds east from Crnićani; 41.231827, 22.636307; 165 m; 9.8.2015.
14. Dojran, Nikolić: Dojran Lake before the camp; 41.236587, 22.717683; 165 m; 9.8.2015.
15. Dojran, Nov Dojran: Dojran Lake at Marshal Tito street; 41.213776, 22.709282; 155 m; 9.8.2015.
16. Dojran, Nov Dojran: Dojran Lake north from Star Dojran; 41.198551, 22.713842; 155 m; 9.8.2015.
17. Dojran, Crnićani: fishpond north from Crnićani; 41.242524, 22.656940; 190 m; 9.8.2015.
18. Dojran, Crnićani: stream south-east from the fishpond, near Jovanov Izvor Spring; 41.240788, 22.656422; 190 m; 9.8.2015.
19. Valandovo, Valandovo: Anska Reka River at the bridge south-west from Valandovo; 41.304937, 22.541630; 80 m; 9.8.2015.
20. Kavadarci, Raec: Raec River in Drenovska Klisura Gorge; 41.437007, 21.860755; 215 m; 10.8.2015.
21. Kavadarci, Fariš: Raec River south-east from Fariš; 41.440540, 21.822173; 270 m; 10.8.2015.
22. Prilep, Prilep: Prilep Lake (= Prilepsko Ezero Reservoir); 41.389349, 21.600503; 750 m; 10.8.2015.
23. Prilep, Štavica: Bukovdelska Reka River north-east from Štavica; 41.267331, 21.577283; 905 m; 11.8.2015.

24. Prilep, Kalen: Kalenska Reka River – dry at this survey; 41.252428, 21.657105; 585 m; 11.8.2015.
25. Prilep, Manastir: Crna Reka River at Hasinbej Most Bridge; 41.195205, 21.714303; 390 m; 11.8.2015.
26. Prilep, Bešište: Satoka Reka River by the Monastery; 41.116114, 21.804475; 805 m; 11.8.2015.
27. Prilep, Vitolište: Buturica Reka River by the Manastir–Vitolište road; 41.168122, 21.783908; 705 m; 11.8.2015.
28. Rosoman, Raec: Raec River at Drenovska Klisura Gorge (L20) with a streamlet flowing into the river, by the unpaved road; 41.437227, 21.860797; 220 m; 11.8.2015.
29. Prilep, Prilep: Loc Kruša Monastery St. Gjorgji; 41.428672, 21.620085; 1.005 m; 11.8.2015.
30. Prilep, Prilep: Prisad Streamlet (= Crnička Reka River) west from Monastery St. Gjorgji; 41.428336, 21.615867; 925 m; 11.8.2015.
31. Prilep, Belo Pole: Dolneni Fishpond south from the Sarandinovo village; 41.417660, 21.410981; 610 m; 12.8.2015.
32. Prilep, Trojkrsti: Crna Reka River with a confluence of Plivska Reka River; 41.236259, 21.401862; 600 m; 12.8.2015.
33. Bitola, Ribarci: Ribarci Blato Lake (fishpond); 41.019388, 21.466716; 580 m; 12.8.2015.
34. Bitola, Gneotino: channel flowing into Crna Reka River north from Gneotino; 40,99111111, 21,4825; 580 m; 12.8.2015.
35. Bitola, Gneotino: a puddle south-east from Gneotino; 40.963611, 21.512203; 585 m; 12.8.2015.
36. Bitola, Skočivir: Crna Reka River bellow St. Archangel Mihail Church; 40.972065, 21.638586; 570 m; 12.8.2015.
37. Bitola, Skočivir: Strašnica Stream tributary of Crna Reka River north-east from St. Archangel Mihail Church; 40.973887, 21.648867; 570 m; 12.8.2015.
38. Bitola, Žabeni: meadow north from Ribnik bel kamen Fishpond (= Fishpond Žabeni); 40.965306, 21.408269; 580 m; 12.8.2015.
39. Prilep, Belovodica: Belovodičko Lake (= Belovodica Lake) and Bela Reka Stream (inflow forest stream south from the lake); 41.335733, 21.697582; 775 m; 13.8.2015.
40. Prilep, Oreovec: a fishpond with a streamlet north from Oreovec village; 41.391668, 21.634739; 850 m; 13.8.2015.
41. Prilep, Pletvar: Pletvar Lake (gravel pits); 41.372322, 21.633564; 925 m; 13.8.2015.
42. Kičevo, Novo Selo: Sateska River; 41.308266, 20.801262; 775 m; 14.8.2015.
43. Kičevo, Novo Selo: Sini Virovi Swamp (= Belčiško Blato Swamp), north-east from Belčišta; 41.317777, 20.816641; 770 m; 14.8.2015.
44. Kičevo, Novo Selo: Matica Chanel at Sini Virovi Swamp; 41.305499, 20.813822; 765 m; 14.8.2015.
45. Ohrid, Ohrid: nort-east part of Ohrid Lake near St. Erazmo Hospital; 41.135430, 20.759861; 700 m; 14.8.2015.

46. Skopje, Skopje: The Old bazar, fountain in the pub's courtyard in the city centre; 42.000556, 21.435550; 260 m; 15.8.2015.

Results

During this nine-day survey, the number of observed species comprised more than half of all known dragonfly species in the country. Altogether 336 records for 41 species were collected on 46 investigated sites. Larvae of seven species, exuviae of 25 and imagines of 38 species were identified. Recorded species with localities are presented in Table 1.

The noteworthy results are new records of several nationally rare species – i.e. *C. microstigma*, *Lindenia tetraphylla* (Vander Linden 1825), *C. insignis*, *Somatochlora flavomaculata* (Vander Linden 1825), *S. meridionale*, *Sympetrum vulgatum* (Linnaeus 1758), *Sympetrum flaveolum* (Linnaeus 1758), *S. nigra* – as well as new populations of *C. heros*, species from the EU Habitats Directive (Council Directive 92/43/EEC). Numerous new records of more common species were also collected. For several species with a relatively low number of previously published records for R. Macedonia, our survey adds new localities and extends their known range in the country.

Table 1. Checklist of dragonfly species recorded during the 5th Balkan OdonatOlogical Meeting (BOOM 2015 – Republic of Macedonia). References for observation sites are given. The locality numbers correspond to the list of localities in the Materials and methods section. Recorded larvae, exuviae and tenerals and altitude range where species were detected are also added. If not stated otherwise, data consist of imagines. Species listed in European Red list of Dragonflies (Kalkman et al. 2010) as threatened or near threatened are printed in bold, while species from Annexes of EU Habitat Directive (Council Directive 92/43/EEC) are marked with *.

	Species	**Locality numbers**	**Alt. (m)**
	LESTIDAE		
1.	*Lestes barbarus* (Fabricius 1798)	3, 12, 17, 31, 39, 40, 41	180–925
2.	*Lestes virens vestalis* (Charpentier 1825)	31, 40	610, 860
3.	*Chalcolestes parvidens* (Artobolevskii 1929)	11, 17, 22, 24 (+ exuvia), 31, 40	145–860
4.	*Sympecma fusca* (Vander Linden 1820)	29, 33, 35, 39	580–1.005
	CALOPTERYGIDAE		
5.	*Calopteryx virgo* (Linnaeus 1758)	12, 17, 18, 20, 21, 23, 26, 27, 30, 32 (+ exuviae), 35, 36 (+ larvae), 39, 42, 43	180–930
6.	*Calopteryx splendens* (Harris 1782)	11, 12, 17, 18 (+ exuvia), 19–21, 24, 25 (+ larva, + exuviae), 27, 32 (+ exuviae), 37	80–705

	PLATYCNEMIDIDAE		
7.	*Platycnemis pennipes* (Pallas 1771)	2–5, 11–13, 17–21, 23, 24, 25 (+ exuviae), 26–28, 31, 32 (+ exuviae), 33, 36–39, 41	80–925
	COENAGRIONIDAE		
8.	*Ischnura elegans* (Vander Linden 1820)	2, 3 (+ exuviae), 6, 11–13, 14 (+ tenerals), 15–18, 22, 24, 25 (+ exuviae), 28, 31, 32 (+ exuviae), 33, 34, 37, 39–41, 45	115–925
9.	*Ischnura pumilio* (Charpentier 1825)	3, 8, 17, 22, 34, 37, 40, 41, 43	165–925
10.	*Enallagma cyathigerum* (Charpentier 1840)	3 (+ exuvia), 14, 15, 22, 39	155–920
11.	*Coenagrion puella* (Linnaeus 1758)	43	750
12.	*Erythromma lindenii* (Sélys 1840)	3, 14, 17, 32 (+ exuvia), 33, 39 (+ exuvia)	165–920
13.	*Erythromma viridulum* (Charpentier 1840)	3, 14–17, 31, 33, 39, 41	155–925
	AESHNIDAE		
14.	*Aeshna affinis* Vander Linden 1820	24, 39, 40	590–860
15.	*Aeshna mixta* Latreille 1805	19 (exuvia), 34 (exuviae), 37 (exuviae), 40 (exuviae)	80–860
16.	*Aeshna cyanea* (Müller 1764)	26, 30 (exuvia), 39, 40, 43 (+ exuviae)	750–930
17.	*Anax imperator* Leach 1815	3 (+ exuviae), 13, 15 (exuvia), 31–33, 37, 39, 40 (+ exuviae), 41 (+ exuvia), 44	150–930
18.	*Anax parthenope* (Sélys 1839)	3 (+exuvia), 15, 16, 31–33, 39	150–920
19.	***Caliaeschna microstigma* (Schneider 1845)**	4, 20 (exuvia), 21 (exuviae), 22 (exuvia), 25 (exuvia), 27 (exuviae), 29, 30 (+ exuviae)	140–1.005
	GOMPHIDAE		
20.	*Gomphus vulgatissimus* Linnaeus 1758	25 (+ larva, + exuviae), 32 (exuvia), 41 (larvae)	390–925
21.	*Onychogomphus forcipatus* (Linnaeus 1758)	5–9, 11 (exuvia), 12 (+ exuvia), 20 (+ exuvia), 21 (+ exuvia), 23, 24, 25 (+ larva, exuviae), 27 (+ exuviae), 32 (exuvia), 34, 36, 37, 45 (+ exuvia)	90–905
22.	***Lindenia tetraphylla* (Vander Linden 1825) ***	14 (exuviae)	165
	CORDULEGASTRIDAE		

23.	***Cordulegaster bidentata* Sélys 1843**	28, 43	220, 750
24.	***Cordulegaster heros* Theischinger 1979 ***	11, 20, 26 (+ larvae), 36 (larvae), 39 (+ larva)	145–805
25.	***Cordulegaster insignis* Schneider 1845**	28	220
	Cordulegaster sp.	21 (wing)	
	CORDULIIDAE		
26.	*Somatochlora flavomaculata* (Vander Linden 1825)	43, 44	765, 770
27.	*Somatochlora meridionalis* Nielsen 1935	22, 39	750, 775
	LIBELLULIDAE		
28.	*Libellula depressa* Linnaeus 1758	3 (+ exuvia), 5, 24, 37, 43	110–920
29.	*Libellula fulva* (Müller 1764)	32 (exuvia)	600
30.	*Orthetrum albistylum* (Sélys 1848)	2, 3, 6, 8, 12–17, 25 (+ larva), 31, 32 (+ exuviae), 33, 34 (exuvia), 37, 39, 41	115–925
31.	*Orthetrum brunneum* (Fonscolombe 1837)	2, 9, 12, 14, 17, 20, 22–25, 31, 34, 37, 40	90–905
32.	*Orthetrum cancellatum* (Linnaeus 1758)	3 (+ exuvia), 12–14, 15 (exuviae), 17, 22, 25, 28, 32, 39, 41, 43, 45	155–925
33.	*Orthetrum coerulescens* (Fabricius 1798)	2, 4, 6, 8–12, 17, 18, 22–24, 28, 31–33, 36, 37	65–905
34.	*Sympetrum flaveolum* (Linnaeus 1758)	43	750
35.	*Sympetrum fonscolombii* (Sélys 1840)	1, 2, 3 (+ exuviae), 7–9, 12–14, 15 (exuvia), 17, 21 (+ teneral), 22–24, 28, 31–33, 37, 39–41, 43, 45, 46	90–925
36.	*Sympetrum meridionale* (Sélys 1841)	2, 16, 31, 40 (+ exuviae)	155–860
37.	*Sympetrum sanguineum* (Müller 1764)	2, 3, 22, 24, 25, 31, 33, 39–41, 43	290–925
38.	*Sympetrum striolatum* (Charpentier 1840)	17, 23, 39 (+ teneral), 40 (+ exuviae, + tenerals)	190–905
39.	*Sympetrum vulgatum* (Linnaeus 1758)	40 (+ exuviae, + teneral)	860
40.	*Crocothemis erythraea* (Brullé 1832)	3 (+ exuvia), 9, 12–14, 15 (+ exuviae), 16, 17, 22, 25, 31, 33, 39, 41	90–925
41.	*Selysiothemis nigra* (Vander Linden 1825)	3 (exuvia), 14, 15 (+ exuviae), 16	150–920

Fig. 2: Belovodičko Lake (L39, A) where we observed the most dragonfly species per site (20) and a fishpond north from Oreovec village (L40, B), 13.8.2015 (photo D. Kulijer).

In terms of number of dragonfly species per site, few showed high biodiversity: Belovodičko Lake (L39: 20 spp., Fig. 2A), Done Popov Lake (L3: 16 spp., Fig. 10A), fishponds near Crnićani (L17: 16 spp.), Sarandinovo (L31: 15 spp.) and Oreovec (L40: 15 spp., Fig. 2B), confluence of rivers at Trojkrsti (L32: 14 spp.), Dojran Lake (L14–L16: 14 spp., Fig. 5). 12 species were recorded on six sites (L12, L22, L33, L37, L41, L43).

The most frequent species were *Platycnemis pennipes* (Pallas 1771) and *Sympetrum fonscolombii* (Sélys 1840), both found at 26 localities (57 % of all investigated sites) (Tab. 1). On more than a third of all the investigated sites *Ischnura elegans* (Vander Linden 1820), *Orthetrum coerulescens* (Fabricius 1798), *Orthetrum albistylum* (Sélys 1848), *Onychogomphus forcipatus* (Linnaeus 1758), *Calopteryx virgo* (Linnaeus 1758), *Crocothemis erythraea* (Brullé 1832), *Orthetrum brunneum* (Fonscolombe 1837) and *Orthetrum cancellatum* (Linnaeus 1758) were recorded. Six species, i.e. *Coenagrion puella* (Linnaeus 1758), *L. tetraphylla*, *C. insignis*, *Libellula fulva* Müller

Fig. 3: *Calopteryx virgo* (A) and *Platycnemis pennipes pennipes* (B) were among the most abundant dragonfly species during this study (photo O. Brauner).

Fig. 4: Atypically coloured females of *Onychogomphus forcipatus* at Demir Kapija (L5, A), 8.8.2015, and at Crna Reka River (L25, B), 11.8.2015 (photo D. Vinko, A and D. Kulijer, B).

1764, *S. flaveolum* and *S. vulgatum* were each observed at only one locality. Most abundant species were *Calopteryx splendens* (Harris 1782), *P. pennipes* and *I. elegans* (with more than 1.000 individuals), *O. albistylum* and *S. fonscolombii* (more than 500 individuals), and with more than 200 individuals *C. virgo* (Fig. 3A), *Ischnura pumilio* (Charpentier 1825), *Erythromma viridulum* (Charpentier 1840), *O. forcipatus*, *O. coerulescens* and *C. erythraea*.

Majority of species recorded on at least two sites (29) were discovered at various altitudes, from approximate 100 m to 950 m (Tab. 1). For other six species recorded on at least two sites altitudinal range was narrower, i.e. *Aeshna cyanea* (Müller 1764) from 750 m to 930 m, *Sympecma fusca* (Vander Linden 1820) from 580 m to 1.005 m above sea level.

All hand checked *P. pennipes* individuals belonged to subspecies *pennipes* (Fig. 3B).

On some of the 19 sites with *O. coerulescens* presence, males were checked for subspecies determination. All showed tendency towards the subspecies *anceps*. Intermediate phenotypes that are closer to the ssp. *anceps* were also encountered. Individual males and females with fully pruinose abdomen and thorax were also recorded.

Some really greenish and dark *O. forcipatus* females were observed on several sites (Fig. 4).

Next to dragonflies also some other interesting animal species were observed during the Meeting. Among them are first findings of two invasive insect species for R. Macedonia reported separately by Kulijer (2016), western conifer seed bug (*Leptoglossus occidentalis* Heidemann, 1910) and harlequin ladybird (*Harmonia axyridis* (Pallas 1773)). Three species listed on the European Habitats Directive (Council Directive 92/43/EEC) were also recorded. European pond turtle (*Emys orbicularis* (Linnaeus 1758), Ann. II, IV) adults were observed at Done Popov Lake (L3), while on the road near Bitola the Greek tortoise (*Testudo hermanni boettgeri* Bour 1987, Ann. II, IV) was seen. At Nov Dojran area (L15–L17) and at Ribarci Blato Lake (L33) the Hungarian leech (*Hirudo verbana* Carena 1820, Ann. V) was caught.

Discussion

Considering the number of collected records (336) and the number of surveyed localities (46) we conclude the 5th BOOM was successful. Even though our results do not contribute any additional dragonfly species for the country, except for the first written documented report of *S. nigra,* these records represent a valuable contribution to the knowledge of the distribution of many species of dragonflies in the R. Macedonia.

As a consequence of short or early flight period, some of the species were either missed or under-recorded, i.e. *C. puella*, which is a widespread species in R. Macedonia (Boudot & Kalkman 2015), while during BOOM was found only at one site (Tab. 1).

Except of *E. fatime*, all enigmatic stream-dwelling species in the focus of our Meeting mentioned in Materials and methods section were detected. Lack of *E. fatime* during this survey is most probably due to incorrect selection of sampling sites with unsuitable habitats for the species, while some other sites where the species was previously confirmed (Bedjanič & Vinko 2012) were desiccated during our survey. Four reports of this species for R. Macedonia exist (Bilek 1966, Karaman 1979, 1981, Bedjanič & Vinko 2012).

Notes on selected species

Based on published records some of the less common or rare species in R. Macedonia were selected and a brief discussion in the contexts of their regional distribution is given:

***Chalcolestes parvidens* (Artobolevskii 1929)** – We recorded the species at six sites in southern and central part of the country, at altitudes from 145 m to 805 m above sea level. At dry Lisička Reka River (L24) also exuvia was found. Except for Prilep Lake (L22) and Dolneni Fishpond (L31) only individual specimens were seen. The distribution of closely related *Chalcolestes viridis* (Vander Linden 1825) and *C. parvidens* in R. Macedonia is still insufficiently known. As the range of both species overlaps in R. Macedonia (Jović & Mihajlova 2009), it is interesting to have more precise data on the local distribution of both species. Until now *C. parvidens* was reported only from Skopje area (Jović & Mihajlova 2009). As the species is probably widespread in the country, only lack of survey is the reason for the single record. Older data from R. Macedonia consist of only *C. viridis* (Buchholz 1963, Karaman 1972, 1981), which was not detected during our survey. As we visited some known sites of *C. viridis* and found only *C. parvidens* individuals, a review of the material, if present, is needed as the presence of both species on same sites is possible.

***Caliaeschna microstigma* (Schneider 1845)** – During our survey, streams and rivers were investigated thoroughly, also for larvae and exuviae. Therefore, presence of *C. microstigma* at eight sites is not surprising, considering known distribution of

the species. The species was observed during the Meeting even away from water, a male was passing by near Monastery St. Gjorgji (L29). Most probably the specimen originated at a small stream west to south-west from Monastery (L30), where two exuviae were recorded, together with exuvia of *A. cyanea* and five *C. virgo* males. Exuviae of *C. microstigma* were also recorded at Raec River (L20: 1, L21: 2, Fig. 11), Crna Reka River (L25: 1), Buturica River (L27: 4) and Prilep Lake (L22: 1). All these sites were visited in the afternoon. Imagines were observed at a stream in Demirkapiska Klisura Gorge (L4), already a known site for the species (Vinko 2012). A permanent population probably occupies the site; therefore, we propose to conduct investigations for larvae and exuviae so the stability of the population can be confirmed. The species was at Raec River during the ECOO post congress tour in 2012 (Kitanova et al. 2013) also recorded (Dinova pers. comm.), so we presume the Raec River supports a stable population of *C. microstigma*.

The European range of *C. microstigma* is restricted to Cyprus, the Aegean Islands and the Balkan Peninsula. Its northern limit runs from north Bulgaria to south-west Croatia (Kalkman & Jović 2015). As the species is not confirmed from Serbia with voucher specimen (Jović 2013), its northern border runs through R. Macedonia (Boudot et al. 2009), where the species was confirmed at several sites (Buchholz 1963, Peters & Hackethal 1986, Adamović 1990, Bedjanič & Bogdanović 2006, Bedjanič et al. 2008, Vinko 2012, Kovacs & Muranyi 2013, Kalkman & Jović 2015). It develops in cold and swift well-oxygenated streams and small rivers with stony, pebble or gravel substrate where at least part of the water is shaded and where pools of calm water provide refuges for the larvae (Breuer & Douma-Petridou 2000, Kovacs & Muranyi 2013). Specimens (including exuviae) during the BOOM were found at a wide altitudinal range, up to approximately 1.000 m (Tab. 1), which is not the most characteristic for *C. microstigma* (Kalkman & Jović 2015). The species occurs mainly in hilly or mountainous regions but most European populations are found below 500 m (Kalkman & Jović 2015).

***Lindenia tetraphylla* (Vander Linden 1825)** – Four exuviae of this species from Annexes II and IV of the EU Habitats Directive (Council Directive 92/43/EEC) had been recorded at Dojran Lake. First published record for the species from R. Macedonia is given by Karaman (1969). Several papers confirm the lasting presence of *L. tetraphylla* at Dojran Lake (Karaman 1981, Peters & Hackethal 1986, Jović & Mihajlova 2009), where a large population is already long known (Bedjanič & Bogdanović 2006). Other known localities from R. Macedonia are from Skopje area, reservoir near Bogdanci, Mavrovo National Park and Mladost Lake near Veles (Peters & Hackethal 1986, Jović & Mihajlova 2009, Krpač et al. 2013, Kitanova et al. 2013). At BOOM, exuviae were found at not easily accessible extensive reed at north-western part of the lake (L14; Fig. 5A), but no imagines were seen. As strong permanent populations of *L. tetraphylla* are rare in Europe (Boudot & Kalkman 2015, Dijkstra 2006), this site is at least regionally very important for conservation of the species.

***Cordulegaster heros* Theischinger 1979** – Another species from Annexes II and IV of the EU Habitats Directive (Council Directive 92/43/EEC) was recorded at five

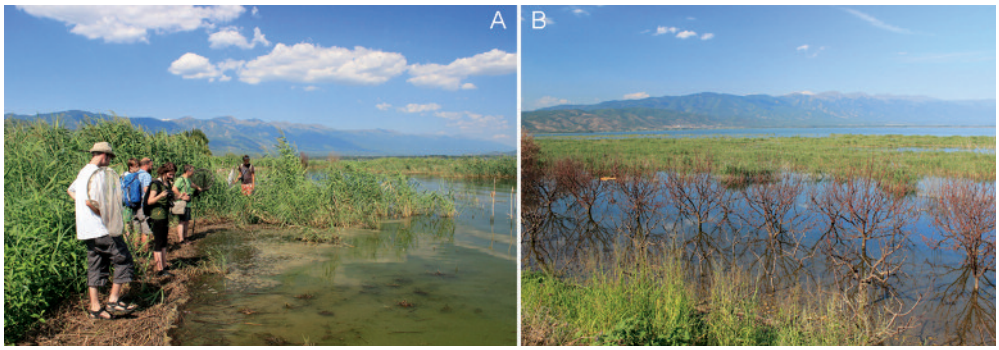

Fig. 5: Two parts of Dojran Lake: north-western (L14, A), where *Lindenia tetraphylla* exuviae were recorded, and western (L15, B), where reproduction of *Selysiothemis nigra* was confirmed, 9.8.2015 (photo O. Brauner).

sites in both investigated parts of the country, with altitudes from 145 m to 805 m above sea level. Larvae of *C. heros* were recorded at Crna Reka River (L36) and Satoka Reka River (L26) rivers and at an inflow of Belovodičko Lake (L39). Adult male was recorded at a stream flowing into Paljurci Lake (L11) and together with *C. microstigma* at Raec River (L20, Fig. 11A). All sites correspond to species requirements.

Cordulegaster heros (Fig. 6A) extends from central to south-east Europe throughout the Balkan Peninsula (Boudot & Kalkman 2015), so new data in R. Macedonia on species distribution is expected as its preferred habitat is present throughout most parts of the country. The species is typical for lower altitudes (Holuša & Krivan 2012) and extends to suitable habitats in the Macedonian lowlands (Bedjanič et al. 2008, Jović 2009, Jović & Mihajlova 2009). Therefore, gaps in its range throughout R. Macedonia are caused by lack of surveys in the country.

***Cordulegaster bidentata* Sélys 1843** – This most wide-ranging endemic dragonfly species to Europe was during our survey recorded at two sites, with one

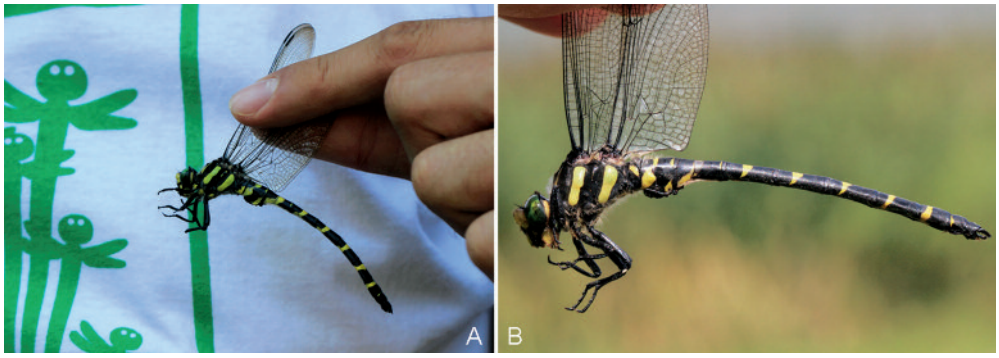

Fig. 6: Side views of *Cordulegaster heros* (A) and *C. bidentata* (B) (photo O. Brauner).

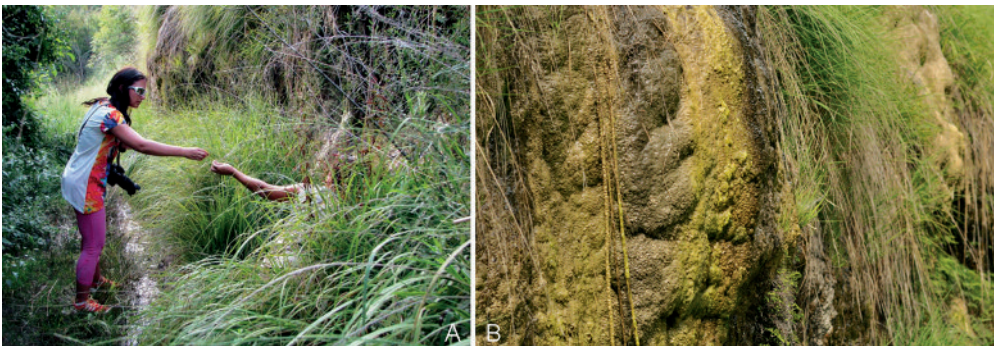

Fig. 7: Locality at Drenovska Klisura Gorge (L28, A) where *Cordulegaster insignis* and *C. bidentata* were recorded, 11.8.2015, with the breeding habitat of *C. insignis* at the same site (B) – petrifying spring with tufa formation, 23.6.2013 (photo D. Kolčakovski, A and D. Dinova, B).

male at each (Fig. 6B). While Raec River (L28) at 220 m above sea level seems suitable habitat for the species, its presence at Sini Virovi Swamp (L43) was less expected. Although at Sini Virovi Swamp at 750 m above sea level, few springs and shorter streams suitable for the species are present. The species was already confirmed for Ohrid area (Boshamer et al. 2006, Bedjanič et al. 2008), as well as for other regions throughout the country (Peters & Hackethal 1986, Adamović 1990, Jović & Mihajlova 2009). According to Peters & Hackethal (1986) *C. bidentata* is supposed to be widespread in more hilly, colder areas of the country. It is thus sparsely present in R. Macedonia, limited mostly to the high mountains (Jović & Mihajlova 2009).

***Cordulegaster insignis* Schneider 1845** – We recorded another *Cordulegaster* species from the *bidentata* group. At the streamlet flowing into Raec River next to the unpaved road by the river at 220 m above sea level (L28, Fig. 7) a dead male was found, together with foraging *C. bidentata* male. From the site, *C. insignis* was already known (Kitanova et al. 2013). The habitat is petrifying spring with tufa formation (Cratoneurion), overgrown with grassy vegetation (Fig. 7B). Up to now, only two sites for this species in R. Macedonia are known (Kitanova et al. 2013).

Distribution of *C. insignis* is restricted to small portion of far south-east Europe and continues to south-west Asia (Kulijer & Boudot 2013). In the European part of its range is generally uncommon and is considered as one of the rarer species of dragonflies in Europe (Boudot et al. 2015). According to Dijkstra (2006) and Holuša & Krivan (2012) *C. insignis* is confined to small and shallow shaded streams and springs with rocky pools and sand beds in cultivated landscape and in forest complexes with rich stands of vegetation, but occasionally inhabits larger and deeper waters. It has only rarely been observed in still waters (Boudot et al. 2015). The habitat requirements of this species are similar to those of *C. bidentata*, but *C. insignis* tends to occupy them at lower and warmer altitudes (Holuša & Krivan 2012).

***Somatochlora flavomaculata* (Vander Linden 1825)** – The southern border of this species' European range runs over south-west France, north Italy, Austria, Slovenia and Hungary (Bedjanič et al. 2008). Further to the south, only scattered populations are known from southern Italy and the Balkans and there is a lack of recent data from most of the Balkan Peninsula countries (Boudot & Kalkman 2015). Situation in R. Macedonia is similar, where after 1990 *S. flavomaculata* is reported only from few sites in north-western, north-eastern and south-eastern parts of the country (Boudot & Kalkman 2015, Vinko 2012).

Our records originate from the same area (south-west R. Macedonia) as the first record of this species for the country which was based on a specimen collected near Struga in 1925 (Bedjanič et al. 2008). Recent presence of *S. flavomaculata* is confirmed also for Mavrovo National Park (Dinova pers. comm.). We observed few males at Sini Virovi Swamp (L43: 1, L44: 3), where another also rare species for R. Macedonia, *Sympetrum flaveolum* was spotted. Both sites in Sini Virovi Swamp (also known as Belčiško Blato Swamp) are typical for *S. flavomaculata*. This unique and rare habitat for R. Macedonia is similar with that in NP Mavrovo – a stream with associated wet meadows, peat bogs and marshy areas where willow and alder woodlands are present (Melovski & Matevski 2008).

***Somatochlora meridionalis* Nielsen 1935** – The species is nearly endemic to Europe (Dijkstra 2006). Its main range extends over most of south-east Europe, with

Fig. 8: *Somatochlora meridionalis* male found at the inflow of the Belovodičko Lake (L39), 13.8.2015 (photo O. Brauner).

high densities of populations known from Slovenia to Montenegro, in Bulgaria and the European part of Turkey (Boudot & Kalkman 2015). In Hungary, Romania, Serbia, Albania, Greece and in R. Macedonia the species has a more scattered occurrence (Boudot & Kalkman 2015). Although it typically breeds in streams and brooks (Dijkstra 2006), a single female along Prilep Lake (L22) and a male specimen at Belovodičko Lake (L39, Fig. 2A) (both central R. Macedonia) were found patrolling along completely stagnant water. Other characteristics of the water body (at least partly shaded, devoid of aquatic vegetation, muddy bottom, shaded inflow) seem to match the requirements of *S. meridionalis*. Additional male (Fig. 8) was caught at a forest stream south from Belovodičko Lake (an inflow of the lake), together with *C. heros* female and two *A. cyanea* males. Both mentioned sites are situated at around 750 m above sea level, which is not characteristic for the species, but was already recorded (Marinov 2007). Previously, *S. meridionalis* was known from south-east and south-west R. Macedonia (Peters & Hackethal 1986, Adamović 1990, Boshamer et al. 2006), therein our data from the central part of the country shows the species is most probably widespread throughout the country.

***Sympetrum vulgatum* (Linnaeus 1758)** – As one of the least common *Sympetrum* species in the Balkan Peninsula (Boudot et al. 2009), *S. vulgatum* is considered rare also in R. Macedonia (Bedjanič & Bogdanović 2006). In south of its range, its distribution is restricted to higher elevations (Kalkman et al. 2015), as was confirmed also in our survey. Previously, the species was for R. Macedonia reported from Prespa Lake area (Karaman 1979, 1984–85). The species is also present in north-east and north-west Greece near the border with R. Macedonia (Lopau 2010, Kalkman et al. 2015).

At the fishpond with a streamlet in the central part of the country near Oreovec at 850 m above sea level (L40, Fig. 2B) two *S. vulgatum* exuviae and five males were recorded, representing a new population of this species for the country. From the locality, we report *S. vulgatum* together with three *S. fonscolombii* males and more than 15 imagines of both sexes of *Sympetrum meridionale* (Sélys 1841), *Sympetrum sanguineum* (Müller 1764), *Sympetrum striolatum* (Charpentier 1840) each. For *S. meridionale* and *S. striolatum* more than 20 exuviae each were collected.

***Selysiothemis nigra* (Vander Linden 1825)** – Our records of adults and exuviae for this species (Fig. 9) at Dojran Lake (L14–L16) and at Done Popov Lake (L3) are thus far the first documented report for *S. nigra* for R. Macedonia. All prior literature either did not contain any data on *S. nigra* for the country, were too vague in the general statements of species' distribution as Macedonia (not clear if they pertained to the country or to the folk region on the Balkans) or did not specify any particular location. Consequently for R. Macedonia there are no available published records of *S. nigra*. Karaman (1979) lists the species for the country, although it was not detected during her intensive work and also no reference is given. Beschovski (1994) also mentions *S. nigra* for R. Macedonia, this data was later recalled by Beschovski (Marinov pers. comm.) in Beschovski & Marinov (2007). However, Beschovski & Gashtarov

Fig. 9: *Selysiothemis nigra* female at Dojran Lake (L14), 9.8.2015 (photo J.-J. Mekkes).

(1997) conclude cited literature in previous publications referred "Macedonia" exclusively to the northern province of Greece and not to R. Macedonia within the nowadays borders. Surprisingly, Beschovski later on again included *S. nigra* for R. Macedonia (Beschovski & Marinov 2007). As the species is reported from south-west Bulgaria near the town of Melnik (Beschovski & Gashtarov 1997) and north-east Greece (Boudot et al. 2009), species' presence in R. Macedonia is not at all surprising. In Greece, the species was also observed in vicinity of the border with R. Macedonia at Ardzan Lake near Dragomir in the province of Kilkis (Campion 1919) and at several other sites in northern part of the country (Campion 1918, 1921, Lopau 2010). Peters & Hackethal (1986) already predicted *S. nigra* as a species most probably found at Dojran Lake in the future. Previous to our survey, *S. nigra* was already recorded at Dojran Lake and in the lower Vardar River valley (Dinova & Jović pers. comm.), only no report is given.

Selysiothemis nigra is distributed throughout most of the Mediterranean Basin, but scattered (Boudot et al. 2009), although from Europe generally comparatively little information on the species' ecology with regards to larval habitats and life cycle is available (Uboni et al. 2015). Records from north-east Italy from artificial lakes approximately 40 km inland represent the northernmost evidence worldwide of species' breeding (Uboni et al. 2015). In the Balkan Peninsula, it is mostly confined to the Adriatic and Mediterranean coasts, where presumably the main hotspots for the species in Europe exist (Kalkman & Bogdanovic 2015). Most records of *S. nigra* are from shallow ponds and lakes, also from brackish habitats (Kalkman

& Bogdanovic 2015), while some records from Italy indicate that the species is able to reproduce also at perennial and deep man-made water bodies (Uboni et al. 2015) and concrete water tanks (Kalkman & Bogdanovic 2015). While the species typical for the coastal areas can be occasionally highly nomadic (Boudot et al. 2009), it was not presumed to be found further inland (Dijkstra 2006). Although in Europe adult individuals are reported far from the coast and even far from the water, but without a proof of its reproduction (Kulijer et al. 2012, De Knijf et al. 2013, Kalkman & Bogdanovic 2015).

During the BOOM, both adults and exuviae were recorded. Three sites are located at one of the largest lakes in the country Dojran Lake, approximately 60 km inland at 160 m above sea level. At western side of the lake three exuviae and a male were discovered south from Nov Dojran (L15, Fig. 5B) and a male near Star Dojran (L16). On the north to north-western side of the lake (L14, Fig. 5A) more than 80 adults of both sexes were flying by the water and at adjacent grasslands, shrubs and farmlands. Females were more abundant near the lakebed, while males at reed. Juveniles of both sexes were also present in lake's vicinity.

Approximately 110 km inland at 920 m above sea level at finely vegetated shallow reservoir in Vitačevo *S. nigra* exuvia was observed (Fig. 10). Done Popov Lake is surrounded by forest, aquatic vegetation is rich, no inflow is present. A total of 16 dragonfly species were recorded on the site: *Lestes barbarus* (Fabricius 1798), *P. pennipes*, *Erythromma lindenii* (Sélys 1840), *E. viridulum*, *S. sanguineum* together with *Enallagma cyathigerum* (Charpentier 1840), *I. elegans*, *I. pumilio*, *Anax imperator* Leach, 1815, *Anax parthenope* (Sélys 1839), *Libellula depressa* Linnaeus 1758, *O. albistylum*, *O. cancellatum*, *S. fonscolombii*, *C. erythraea* and *S. nigra,* for all of them also their reproduction was confirmed.

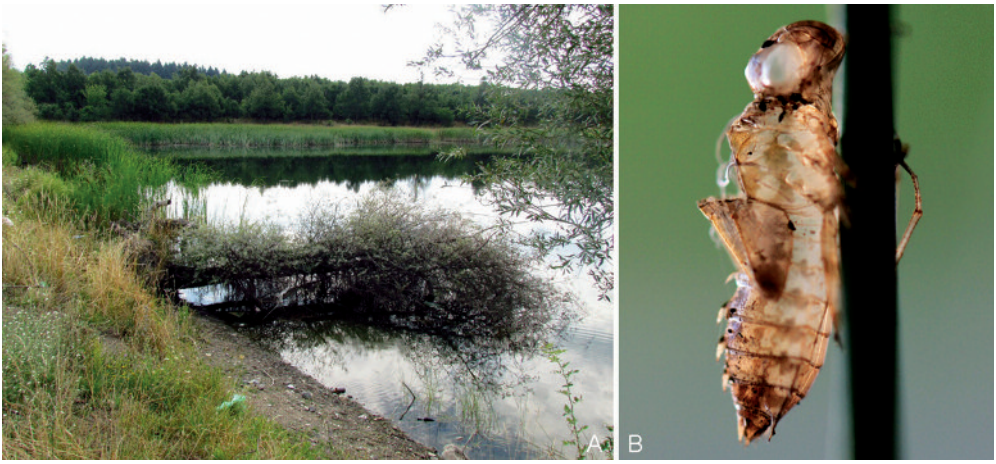

Fig. 10: Done Popov Lake (L3, A) where *Selysiothemis nigra* exuvia (B) was recorded together with 15 other dragonfly species, 8.8.2015 (photo D. Kulijer, A and O. Brauner, B).

Conservation perspective

Among recorded species *C. microstigma*, *C. heros* and *C. bidentata* are included in the European Red List of Dragonflies (Kalkman et al. 2010) as near threatened (NT) species, *L. tetraphylla* as vulnerable (VU) and *C. insignis* as endangered (EN). In the Mediterranean Red list (Boudot et al. 2009) *C. microstigma*, *L. tetraphylla*, *C. bidentata*, *C. insignis*, *S. vulgatum* are listed as near threatened species and *C. heros* as vulnerable. Two species, *L. tetraphylla* and *C. heros*, are protected by the European Habitats Directive (Council Directive 92/43/EEC).

Additionally, several recorded species, i.e. *C. parvidens*, *A. cyanea*, *C. microstigma*, *C. insignis*, *S. flavomaculata*, *S. meridionalis*, *S. flaveolum*, *S. vulgatum* and *S. nigra*, are rare or have restricted distribution in R. Macedonia (Boudot & Kalkman 2015).

Raec River in Drenovska Klisura Gorge (L20, L28, Fig. 7, 11A) proved to be very interesting site considering the diversity of dragonfly fauna. The area is a narrow, semi-deep, canyon-type creek valley in limestone bedrock. The substrate of the riverbed is made up of a mixture of mud, gravel and leaf litter with dead twigs, with stones and submerged moss also present. Irregularly small pools with slower water flow occur. The river is partly shaded, with well insulated larger sections. When at least one side of the riverbed is covered with trees, the other is covered with well-developed aquatic vegetation, herbs and shrubs. 13 species of dragonflies were discovered there; both *Calopteryx* spp., *I. elegans*, *P. pennipes*, *O. forcipatus*, three *Orthetrum* spp. and *S. fonscolombii*. Most interesting is the finding of *C. microstigma* and all three in the survey recorded *Cordulegaster* spp. Exuviae were recovered only of *C. microstigma*, no larvae were sampled. Even though *C. microstigma* and *Cordulegaster* spp. have similar habitat requirements they generally tend to occupy different sites, at different altitudes. As stated in previous section, *C. heros* is typical for lower altitudes, *C. insignis* tends to occupy sites at lower and warmer altitudes, while *C. bidentata* prefers higher elevations and colder habitats. *Caliaeschna microstigma* is present in various altitudes, but prefers colder waters. Habitat of the Raec River about 5 km downstream (L21, Fig. 11B) changes. It has a wider riverbed, more rocks (also bigger) are present in the substrate, water flow is faster, water is shallower. The presence of *C. microstigma* and one *Cordulegaster* sp. (recovered one wing) was confirmed at this site. Drenovska Klisura Gorge is proclaimed as a Natural Monument on a national level (Category III according to IUCN classification) and dragonfly fauna present in the area should be taken as priority when considering development management measures in the future.

Beside the sites with the presence of species of European concern also several other sites are interesting when considering conservation of aquatic habitats and dragonfly species.

Belčiško Blato Swamp (L43, L44) has a higher diversity (12 spp.) and host some rare dragonfly species in the Balkans such as *S. flavomaculata*, *C. bidentata*, *S. flaveolum*. The swamp has a suitable habitat which can support a stable dragonfly populations, especially for rare *S. flavomaculata*. Belčiško Blato Swamp is proposed as a Natural Monument on a national level (Melovski et al. 2011). The relict wetland communities that are present there are preserved in a fragmentary state (only seven

Fig. 11: Raec River in Drenovska Klisura Gorge (A: L20, B: L21), where three *Cordulegaster* species and *Caliaeschna microstigma* were recorded, 10.8.2015 (photo D. Kulijer).

smaller marshes still exist) and their flora and fauna species are of the most endangered (Fifth… 2014). Recommendation was made to designate Belčiško Blato Swamp for protected area under special management regime, so appropriate management measures for protection of dragonfly community and habitats should be developed and included in the management plan for this area.

The site with the most recorded species, Belovodičko Lake (L39, Fig. 2A) beside *C. heros* hosts *E. lindenii*, *S. meridionalis, A. parthenope*, *Aeshna affinis* Vander Linden 1820 and *A. cyanea*.

Altogether for fishpond north from Crnićani (L17) 18 species are reported by this study and by Vinko (2012, pers. comm.): *S. fusca*, *P. pennipes*, *E. cyathigerum*, *I. elegans*, *I. pumilio*, *Aeshna isoceles* (Müller 1767), *Aeshna mixta* Latreille 1805, *A. cyanea*, *Anax ephippiger* (Burmeister 1839), *A. imperator*, *A. parthenope*, *C. erythraea*, *L. depressa*, *O. albistylum*, *O. cancellatum*, *S. fonscolombii*, *S. sanguineum*, *S. striolatum*. From latter, *A. ephippiger* was not recorded during our survey.

Together with diverse fishpond near Oreovec (L40, Fig. 2B) sites mentioned in this section have to be taken in consideration as the sites of at least wider regional importance for conservation of odonates.

Conclusions

The faunistic results of the BOOM 2015 present a significant improvement in the knowledge of the dragonfly fauna of R. Macedonia. They confirm the importance of the BOOM for the odonatological research in the Balkans, in addition to educational role and cooperation of odonatologists from Balkan countries.

In many aspects, R. Macedonia is still an uncharted territory and certainly holds many important new discoveries. We hope that our manuscript will contribute to more systematic research of dragonflies in R. Macedonia and hopefully also to the conservation of its rich flora and fauna.

Acknowledgements

Thanks to other BOOM 2015 participants JAN-JOOST MEKKES (the Netherlands), SAŠA RAJKOV, MARIJA GAJIĆ, LENA KULIĆ, KSENIJA BOGDANOVIĆ (Serbia), IVA MILJEVIĆ (Bosnia and Herzegovina), MAJA HOSTNIK, PETER KOGOVŠEK, JAKA SNOJ, TAJDA TURK (Slovenia), who also participated in this field survey and helped with their observations and identifications.

BOOM 2015 was made possible thanks to the financial support of the Student Organisation of the University of Ljubljana (Slovenia), Macedonian Ecological Society (R. Macedonia) and Gesellschaft deutschsprachiger Odonatologen (Germany). For cooperation and given logistic support at the Meeting we would like to thank Aleksandar Rimčeski, Marjan Kolev (R. Macedonia) and Klaus-Jürgen Conze (Germany).

We wish to express our thanks to Ali Šalamun (Slovenia), Milen Marinov (New Zealand) and Miloš Jović (Serbia), who provided valuable literature, corrections and comments for the improvement of this paper.

References

Adamović Ž. R., 1990: Odonata collected in Strumička kotlina, Macedonia, Yugoslavia. *Bulletin of Natural History Museum Belgrade,* B 45: 47–59.

Bedjanič M., Bogdanović T., 2006: Regional guide to dragonflies: Other states of former Yugoslavia. In: *Field guide to the Dragonflies of Britain and Europe*. Dijkstra K-D.B. (edit.), British Wildlife Publishing, Dorset: 57.

Bedjanič M., Micevski N., Micevski B., 2008: On the dragonfly collection in the Natural History Museum in Struga, Macedonia (Insecta: Odonata). *Biologia Macedonica*, 61: 97–105.

Bedjanič M., Vinko D., 2012: New records of *Epallage fatime* (Charpentier, 1840) in Macedonia (Odonata: Euphaeidae). *Natura Sloveniae,* 14: 15–22.

Beschovski V., 1994: *Fauna Bulgarica. Insecta, Odonata*. Academia Scientiarum Bulgarica, Sofia, 372 p.: 231.

Beschovski V., Gashtarov V., 1997: *Selysiothemis nigra* (Vander Linden, 1825) a new genus and species for the Bulgarian fauna (Odonata: Anisoptera: Libellulidae). *Entomol. Z.*, 107: 309–310.

Beschovski, V., Marinov M., 2007: Fauna, Ecology, and Zoogeography of Dragonflies (Insecta: Odonata) of Bulgaria. In: *Biogeography and Ecology of Bulgaria*. Fet V., Popov A. (edit.), Springer: 199–231.

Bilek A., 1966: Ergebnisse der Albanien-Expedition 1961 des Deutschen Entomologischen Institutes. 46. Beitrag. Odonata. *Beitr. Entomol.,* 16: 327–346. [in German]

Boshamer J., Buys J., Bekker P. J., Mostert K., Vogelaers L., Willemsen J., 2006: Libellen. In: *Zoogdieronderzoek Nationaal Park Galicica (Macedonie).* Willemsen J., Bekker J. P. (edit.), Vereniging voor Zoogdierkunde en Zoogdierbescherming, Arnhem: 50. [in Dutch]

Boudot J.-P., Kalkman V.J. (edit.), 2015: *Atlas of the European dragonflies and damselflies.* KNNV Publishing, The Netherlands, 381 p.

Boudot J.-P., Kalkman V. J., Azpilicueta Amorín M., Bogdanović T., Cordero Rivera A., Degabriele G., Dommanget J.-L., Ferreira S., Garrigós B., Jović M., Kotarac M., Lopau W., Marinov M., Mihoković N., Riservato E., Samraoui B., Schneider W., 2009: Atlas of the Odonata of the Mediterranean and North Africa. *Libellula Supplement*, 9: 1–256.

Boudot J.-P., Marinov M., Kutsarov Y., 2015: *Cordulegaster insignis* Schneider, 1845. In: *Atlas of the European dragonflies and damselflies.* Boudot J.-P., Kalkman V.J. (edit.), KNNV Publishing, The Netherlands: 218–219.

Breuer M., Douma-Petridou E., 2000: A Greek mountain stream (N Peloponnesus) as habitat of *Caliaeschna microstigma* (Odonata: Aeshnidae). *Libellula Supplement*, 3: 1–7.

Buchholz K.F., 1963: Odonaten aus Mazedonien. *Opuscula Zoologica,* 70: 1–16. [in German]

Campion H., 1918: On a small collection of dragonflies from Macedonia. *The Entomologist*, 51: 128–129.

Campion H., 1919: On some further dragonflies from Macedonia. *The Entomologist*, 52: 202–206.

Campion H., 1921: A supplementary note on Macedonian dragonflies. *The Entomologist,* 54: 262.

Darudova S., 2015a: Biologi od Evropa istraživaat vilinski konjćinja po Makedonija. Dnevnik, online, 11.8.2015. *http://www.dnevnik.mk/?ItemID=D5D3A3EA077F654BAF349D5E246E0C86* [20.10.2016] [in Macedonian]

Darudova S., 2015b: Biologi od Evropa istraživaat vilinski konjćinja po Makedonija. *Dnevnik*, 42 015 on 12.8.2015. [in Macedonian]

De Knijf G., Vanappelghem C., Demolder H., 2013: Odonata from Montenegro, with notes on taxonomy, regional diversity and conservation. *Odonatologica,* 42: 1–29.

Dijkstra K.-D. B. (edit.), 2006: *Field guide to the Dragonflies of Britain and Europe.* British Wildlife Publishing, Dorset, 320 p.

Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. OJ L 206, 22.7.1992, OJ L 158, 10.6.2013.

Fifth National report to the Convention on Biological Diversity of the Republic of Macedonia, 2014. Ministry of Environment and Physical Planning, Skopje: 118 p.

Filevska A., 1954. Odonata der Umgebung des Ohridsees. *Fragmenta balcanica Musei macedonici scientiarum naturalium,* 1: 93–102. [in Macedonian, German summary]

Holuša O., Holušova K., 2012: The first findings of larvae of *Cordulegaster insignis* (Odonata: Cordulegastridae) in Macedonia. *Acta Musei Beskidensis,* 4: 51–54.

Holuša O., Krivan V., 2012: A population of *Cordulegaster insignis* (Schneider, 1845) in Macedonia (Odonata: Cordulegastridae). *Acta Musei Moraviae, Scientiae biologicae Brno*, 97: 1–5.

Hristovski S., Slavevska Stamenković V., Hristovski N., Arsovski K., Bekchiev R., Chobanov D., Dedov I., Devetak D., Karaman I., Kitanova D., Komnenov M., Ljubomirov T., Melovski D., Pešić V., Simov N., 2015: Diversity of invertebrates in the Republic of Macedonia. *Macedonian Journal of Ecology and Environment,* 17: 5–44.

Jović M., 2009: Report on Macedonia 2008 project – Odonata. *IDF-Report,* 21: 1–23.

Jović M., 2011: BOOM-ing. *Erjavecia,* 26: 2–3.

Jović M., 2013: A proposal of Serbian names for dragonfly species (Insecta: Odonata) of the Balkan Peninsula, with the checklist of Odonata of Serbia. *Acta entomologica serbica,* 18: 1–10.

Jović M., Mihajlova B., 2009: Catalogue of the Odonata collection in the Macedonian Museum of Natural History. *Acta entomologica serbica,* 14: 133–146.

Kalkman V. J., Bogdanovic T., 2015: *Selysiothemis nigra* (Vander Linden, 1825). In: *Atlas of the European dragonflies and damselflies.* Boudot J.-P., Kalkman V.J. (edit.), KNNV Publishing, The Netherlands: 291–293.

Kalkman V. J., Boudot J.-P., Bernard R., Conze K.-J., De Knijf G., Dyatlova E., Ferreira S., Jović M., Ott J., Riservato E., Sahlén G., 2010: *European Red List of Dragonflies.* Publications Office of the European Union, Luxembourg, 29 p.

Kalkman V. J., Jović M., 2015: *Caliaeschna microstigma* (Schneider, 1845). In: *Atlas of the European dragonflies and damselflies.* Boudot J.-P., Kalkman V.J. (edit.), KNNV Publishing, The Netherlands: 184–185.

Kalkman V. J., Šacha D., David S., 2015: *Sympetrum vulgatum* (Linnaeus, 1758). In: *Atlas of the European dragonflies and damselflies.* Boudot J.-P., Kalkman V.J. (edit.), KNNV Publishing, The Netherlands: 311–313.

Karaman B. S., 1969: Contribution a la connaissance de la faune des Odonates en Macedoine. *Fragmenta balcanica Musei macedonici scientiarum naturalium Skopje,* 7: 93–102. [in French]

Karaman B. S., 1972: *Prilog poznavanju faune Odonate u ekosistemu Dojranskog jezera.* Magistarski rad. Prirodoslovno-matematički fakultet Sveučilišta u Zagrebu, Zagreb, 90 p. [in Serbo-Croatian]

Karaman B. S., 1979: *Ekološko faunistička istraživanja faune odonata SR Makedonije.* Disertacija. Prirodoslovno-matematički fakultet Sveučilišta u Zagrebu, Zagreb, vi+152 p. [in Serbo-Croatian]

Karaman B. S., 1981: Contribution a la connaissance de la faune des Odonates du Lac de Doiran. *Annales Fakultet Biologija, Skopje,* 34: 215–222. [in French]

Karaman B. S., 1984–85: Les Odonates du lac de Prespa (Macedoine, Yougoslavie). I partie: La composition qualitative et l'analyse zoogeographique de la faune. *Ann. Fac. Sci. Nat. Biol., Skopje*: 37–38, 97–110. [in French, Serbo-Croatian summary]

Kitanova D., 2015: Country accounts: Macedonia, Republic of. In: *Atlas of the European dragonflies and damselflies.* Boudot J.-P., Kalkman V.J. (edit.), KNNV Publishing, The Netherlands: 48.

Kitanova D., Boudot J.-P., Nielsen E., Ferreira S., Conze K.-J., Post M., Vilenica M., 2013: Ergebnisse einer einwöchigen Geländeexkursion zur Kartierung von Libellen in Macedonien und Albanien im Juli 2012. Poster. In: *31. Jahrestagung der Gesellschaft deutschsprachiger Odonatologen*: 55. [in German]

Kitanova D., Slavevska-Stamenković V., Kostov V., Marinov M., 2008: Contribution to the knowledge of dragonfly fauna of the Bregalnitsa river, Macedonia (Insecta: Odonata). *Natura Montenegrina,* 7: 169–180.

Kovacs T., Muranyi D., 2013: Larval data of *Caliaeschna microstigma* (Schneider, 1845) from the Balkan Peninsula, with contributions to its biology (Odonata: Aeshnidae). *Folia Historico Naturalia Museimatraensis,* 37: 21–28.

Krpač V. T., Krpač M., Lemonnier-Darcemont M., Darcemont C., Postolov M., Lazarevska S., 2013: Invertebrates fauna (Invertebrata) in the National Park of Mavrovo. *Plant protection,* 24: 7–180.

Kulijer D., 2016: *Leptoglossus occidentalis* (Heteroptera: Coreidae) and *Harmonia axyridis* (Coleoptera: Coccinellidae), two new invasive alien species for insect fauna of Macedonia. *Ecologica Montenegrina,* 5: 22–25.

Kulijer D., Boudot J.-P., 2013. First evidence of the occurrence of *Cordulegaster insignis* Schneider, 1845 in Serbia (Anisoptera: Cordulegastridae). *Odonatologica,* 42: 55–61.

Kulijer D., Miljević I., Jakovljev J., 2016. Contribution of the participants of the 4th Balkan Odonatological Meeting to the knowledge of Odonata distribution in Bosnia and Herzegovina. *IDF-report,* 95: 1–25.

Kulijer D., Vinko D., Billqvist M., Mekkes J.-J., 2012: Contribution to the knowledge of the Odonata fauna of Bosnia and Herzegovina – Results of the ECOO 2012. *Natura Sloveniae,* 14: 23–38.

Lopau W., 2010: Verbreitungsatlas der Libellen in Griechenland (Odonata). *Libellula Supplement*, 10: 5–153.

Marinov M., 2007: Odonata of the western Rhodopes, with special reference to the wetlands north of the town Smolyan, south Bulgaria. *Notulae Odonatologicae,* 6: 97–108.

Melovski L., Hristovski S., Brajanoska R., Velevski M., Sarov S., Avukatov V., 2011: Development of representative protected areas' system in the Republic of Macedonia based on GIS methodology. In: *Proceedings of the conference Nature protection in XXI century. Žabljak, Montenegro, 20-23.09.2011*. Zavod za zaštitu prirode Crne Gore, Podgorica: 95–109.

Melovski L., Hristovski S., Velevski M., Avukatov V., 2008: *Final Construction of Corridor X, Highway E-75, Section Demir Kapija–Smokvica, Environmental Impact Assesment Study - Revised.* Civil Engineering Institute »Makedonija« J. S., Fund for national and regional roads of the Republic of Macedonia, Skopje, 274 p. + app.

Melovski L., Matevski V., 2008: Development of criteria for the selection of wetland habitats for strict protection – case study of Bunec site in the National Park "Mavrovo". Zbornik na trudovi od III kongres na ekolozite od Makedonija, Skopje. *Posebni izdanija na Makedonsko ekološko društvo*, 8: 157–166.

Micevski N., Micevski B., Bedjanič M., 2008: *Aeshna cyanea* and *A. juncea*, new for the fauna of Macedonia (Odonata: Aeshnidae). *Libellula,* 27: 267–274.

Peters G., Hackethal H., 1986: Notizen über die Libellen (Odonata) in Mazedonien. *Acta musei Macedonici scientiarum naturalium,* 18: 125–158. [in German]

Rajkov S., Vinko D., Aranđelović A., 2015. Faunistic results from the 2nd Balkan OdonatOlogical Meeting – BOOM 2012, Serbia. *Natura Sloveniae,* 17: 67–76.

Smiljkov S., Slavevska-Stamenković V., Prelić D., Paunovic M., 2008: Distribution of benthic macroinvertebrates in Mantovo Reservoir (South-East part of the R. Macedonia). Conference of Water Observation and Information System for Decision Support (BALWOIS). Proceedings: 1–12.

Šácha D., Bedjanič M., 2011: Ponovno odkritje ogroženega rumenega porečnika *Gomphus flavipes* (Charpentier, 1825) v Sloveniji po pol stoletja (Odonata: Gomphidae). *Natura Sloveniae,* 13: 37–43. [in Slovene]

Uboni C., Nadalon G., Schröter A., 2015. Evidence of breeding of *Selysiothemis nigra* in the regions of Friuli Venezia Giulia and Veneto, northeastern Italy (Odonata: Libellulidae). *Notulae odonatologicae,* 8: 128–136.

Vinko D., 2011a: BOOM 2011: First Balkan OdonatOlogical Meeting, Prvo mednarodno srečanje odonatologov Balkana, Slovenija, 11.–18. julij 2011. *Erjavecia,* 26: 3–6. [in Slovene]

Vinko D., 2011b: BOOM 2011 Favnistični pregled. *Erjavecia,* 26: 7–12. [in Slovene]

Vinko D., 2012: Poročilo odonatološke skupine. In: *Ekosistemi Jadrana – Makedonija 2010.* Borko Š. (edit.), Društvo študentov biologije, Ljubljana: 8–16 [in Slovene, English summary]

Vinko D., Jović M., Rajkov S., 2012. BOOM: The first (larval) instar of joined Balkan odonatology. In: *ECOO2012, The Second European Congress on Odonatology, Book of abstracts, Belgrade, Serbia, July 2-6, 2012.* Jović M., Anđus L., Bedjanič M., Marinov M. (edit.), Natural History Museum in Belgrade & Entomological Society of Serbia, Belgrade: 49–50.

Vinko D., Kulić L., Gajić M., 2016: BOOM 2016, 6th Balkan OdonatOlogical Meeting, 6. Mednarodno srečanje odonatologov Balkana, jugovzhodna Srbija, 5.–12. avgust 2016. *Erjavecia,* 31: 13–22. [in Slovene]

Vinko D., Vilenica M., 2013: BOOM 2013, 3rd Balkan OdonatOlogical Meeting, tretje Mednarodno srečanje odonatologov Balkana, Hrvaška, 1.–7. avgust 2013: Rezultati. *Erjavecia,* 28: 10–19. [in Slovene]

Zawal A., Stojanovski S., Smiljkov S., 2010: Preliminary Investigations on Odonata from the Lake Ohrid (Macedonia). *Biotechnology & Biotechnological Equipment,* 24: 636–638.

Received / Prejeto: 16. 2. 2017

ACTA ENTOMOLOGICA SLOVENICA
LJUBLJANA, JUNIJ 2017 Vol. 25, št. 1: 115–118

FAVNISTIČNI ZAPISKI / FAUNISTICAL NOTES

FIRST REPORT OF INVASIVE SPECIES *LEPTOGLOSSUS OCCIDENTALIS* IN KOSOVO (HETEROPTERA: COREIDAE)

Dejan KULIJER[1] and Halil IBRAHIMI[2]

[1] National Museum of Bosnia and Herzegovina, Zmaja od Bosne 3, 71000 Sarajevo, Bosnia and Herzegovina; dejan.kulijer@gmail.com
[2] Department of Biology, Faculty of Mathematical and Natural Sciences, University of Prishtina "Hasan Prishtina", Mother Teresa p.n. 10000 Prishtina, Kosovo; halil.ibrahimi@uni-pr.edu

Abstract – First records of the invasive western conifer seed bug (*Leptoglossus occidentalis* Heidemann, 1910) in Kosovo are presented and discussed. This finding complements the known range of the species in the Balkan Peninsula with Albania now being the only country without confirmation of its presence.

KEY WORDS: alien species, Balkan Peninsula, distribution, Hemiptera, insects, Pinaceae, true bugs.

Izvleček – PRVO POROČANJE O INVAZIVNI VRSTI *LEPTOGLOSSUS OCCIDENTALIS* NA KOSOVU (HETEROPTERA: COREIDAE)

Predstavljeni so prvi podatki o pojavljanju tujerodne invazivne stenice storževe listonožke (*Leptoglossus occidentalis* Heidemann, 1910) na Kosovu. To poročanje dopolnjuje znano razširjenost vrste na Balkanskem polotoku, od koder je sedaj potrjena prisotnost vrste v vseh državah z izjemo Albanije.

KLJUČNE BESEDE: tujerodne vrste, Balkanski polotok, razširjenost, Hemiptera, storževa listonožka, Pinaceae, polkrilci.

Western conifer seed bug (*Leptoglossus occidentalis* Heidemann, 1910) is an invasive species of Nearctic origin native to the area of North America west of Rocky

Mts., from British Columbia to North Mexico (McPherson et al. 1990; Dusoulier et al. 2007). First introduction to Europe was recorded in Italy, near Vicenza in 1999 (Taylor et al. 2001). *L. occidentalis* spread fast across the continent and within 15 years it was reported from all parts of Europe, including Portugal, England, Norway, Turkey, Ukraine and Russia (Fent & Kment 2011; Gapon 2013). Although its expansion in Italy and neighboring countries was probably the result of natural spreading of established Italian population, some other isolated and mutually distant records suggest independent introductions or secondary translocations within Europe (Dusoulier et al. 2007; Rabitsch 2008).

In North America the Western conifer seed bug is considered to be a serious pest in seed orchards of conifers (e. g. McPherson et al. 1990). The species feeds on developing seeds and flowers of different conifer species, with a preference for Pinaceae, causing reduction of seed fertility. Another negative impact of *L. occidentalis* is that it can also become the nuisance to people. As the weather cools in autumn, adults search suitable sheltered overwintering places for hibernation and often aggregate in homes and other buildings, sometimes in large numbers (Fent & Kment 2011).

Although *L. occidentalis* already spread across the whole Balkan Peninsula (Fent & Kment 2011) until now it was not reported from Kosovo. This paper presents first documented and verified observations of the species for this country. Adult western conifer seed bugs were collected at four sites in eastern (13/VII/2015) and western (20/III/2016) Kosovo (Fig. 1). The sampling was carried out by handpicking and the collected specimens were preserved in 80 % ethanol. *L. occidentalis* from Batllavë Lake and Ballaban village are deposited at the Laboratory of Zoology of the Department of Biology, Faculty of Mathematical and Natural Sciences, University of Prishtina, Kosovo. One specimen from the Patriarchate of Pejë/Peć is deposited in the collections of the National Museum of Bosnia and Herzegovina in Sarajevo. Both localities in the east are situated in the area of Batllavë Lake, one of the largest lakes in Kosovo, while the localities in western part of Kosovo, Pejë Monastery and Deçan Monastery, are located at the foothills of Bjeshkët e Nemuna Mountains.

Fig. 1: Study area and the finding sites of *Leptoglossus occidentalis* Heidemann in Kosovo.

Fig. 2: *Leptoglossus occidentalis* Heidemann at Visoki Dečani/Deçan. Photo: D. Kulijer.

Material examined: **Loc. 1. Podujevë Municipality, Batllavë Lake**, N 42.817626° E 21.310313°, 13/VII/2015, 653 m a.s.l., 2 adults, H. Ibrahimi leg. & det.; **Loc. 2. Podujevë Municipality, Ballaban village**, N 42.795226° E 21.322476°, 13/VII/2015, 682 m a.s.l., 1 adult, H. Ibrahimi leg. & det.; **Loc. 3. Pejë Municipality, Garden of the Patriarchate of Peć/Pejë**, N 42.661111° E 20.265556°, 20/III/2016, 543 m a.s.l., 1 adult, D. Kulijer leg. & det; **Loc. 4. Deçan Municipality, Visoki Dečani (Deçan) Monastery**, N 42.547222° E 20.266944°, 20/III/2016, 660 m a.s.l., 6 adults, D. Kulijer leg. & det (Fig. 2).

As Balkan Peninsula is largely undersampled for *L. occidentalis* in comparison to other parts of Europe, it can be assumed that the species is much more common in the area then can be seen from available data. The recent discovery of *L. occidentalis* in Macedonia (Kulijer 2016) and now Kosovo complements the known range of the species in the Balkan Peninsula with Albania now being the only country without published data on the species presence.

L. occidentalis probably arrived in Kosovo through natural expansion from neighboring countries, in some of which it was known several years before (Hradil 2008; Protić 2008). Species discovery at multiple locations in different regions of Kosovo

suggests existence of an established population in the country, and not accidentally introduced individuals. It is too early to say if or what will be the effect of the western conifer seed bug to commercial forestry in Kosovo. So far in Europe there are no reports on any major damage to conifer seed orchards or forests (Rabitsch 2008). Future monitoring of this invasive species is needed as mass development could represent serious threat to the forests and seed production in forestry.

References

Dusoulier, F., Lupoli, R., Aberlenc, H.-P., Streito, J.-C., 2007: L'invasion orientale de *Leptoglossus occidentalis* en France: bilan de son extension biogéographique en 2007 (Hemiptera Coreidae). *L'Entomologiste*, 63 (6): 303–308.

Fent, M., Kment, P., 2011: First record of the invasive western conifer seed bug *Leptoglossus occidentalis* (Heteroptera: Coreidae) in Turkey. *North-Western Journal of Zoology,* 7 (1): 72–80.

Gapon, D. A., 2013: First records of the western conifer seed bug *Leptoglossus occidentalis* Heid. (Heteroptera, Coreidae) from Russia and Ukraine, regularities in its distribution and possibilities of its range expansion in the Palaearctic region. *Entomological Review*, 93 (2): 174–181.

Hradil, K., 2008: *Leptoglossus occidentalis* (Heteroptera: Coreidae) A new alien species in Montenegro. *Acta Entomologica Serbica*, 13: 77–79.

Kulijer, D., 2016: *Leptoglossus occidentalis* (Heteroptera: Coreidae) and *Harmonia axyridis* (Coleoptera: Coccinellidae), two new invasive alien species for insect fauna of Macedonia. *Ecologica Montenegrina*, 5: 22–25.

McPherson, J. E., Packauskas, R. J., Taylor, J., O´Brien, M. F., 1990: Eastern range extension of *Leptoglossus occidentalis* with a key to *Leptoglossus* species of America north of Mexico (Heteroptera: Coreidae). *The Great Lakes Entomologist*, 23 (2): 99–104.

Protić, Lj., 2008: *Leptoglossus occidentalis* Heidemann (Heteroptera: Coreidae) in Serbia. *Acta Entomologica Serbica*, 13: 81–84.

Rabitsch, W., 2008: Alien true bugs of Europe (Insecta: Hemiptera: Heteroptera). *Zootaxa,* 1827: 1–44.

Taylor, S. J., Tescari, G., Villa, M. 2001: A Nearctic pest of Pinaceae accidentally introduced into Europe: *Leptoglossus occidentalis* (Heteroptera: Coreidae) in northern Italy. *Entomological News,* 112: 101–103.

Received / Prejeto: 31. 3. 2017