Acta entomologica serbica, 2016, 21: 1-12

UDC 595.753(497.11)
DOI: 10.5281/zenodo.108592

FIRST BIOACOUSTIC SURVEY OF SINGING CICADAS (HEMIPTERA: CICADIDAE) IN SERBIA

MATIJA GOGALA[1] and TOMI TRILAR[2]

1 Slovenian Academy of Sciences and Art, Novi trg 3, SI-1000 Ljubljana, Slovenia
E-mail: matija.gogala@guest.arnes.si
2 Slovenian Museum of Natural History, Prešernova 20, P.O.Box 290, SI-1001 Ljubljana, Slovenia
E-mail: ttrilar@pms-lj.si

Abstract

New data on the distribution of singing cicadas in Serbia were collected with a bioacoustic approach. Six species were detected in SW Serbia and on Mt. Avala between 4 and 12 June, 2014. Three of the species are new for this country − *Cicadetta montana* sensu stricto, *C. cantilatrix* and *C. macedonica.* For the other three species, *Dimissalna dimissa, Cicadivetta tibialis* and *Tettigettula pygmea*, new distributional data are reported.

KEYWORDS: Cicadidae, Serbia, acoustic survey

Introduction

Investigations of cicadas in recent decades have shown that in many cases the best method for the detection and discrimination of single species of Cicadidae is by recording and analyzing their acoustic emissions (Boulard, 1995; Gogala & Trilar, 2004; Puissant & Sueur, 2010; Gogala, 2013). However, till now singing cicadas in Serbia were investigated by classical entomological methods only (Horvath, 1903; Janković, 1975, 1976, 1978; Lekić, 1967a, b). According to Janković (1978), altogether 9 species of Cicadidae were found in Serbia. Due to recent results of investigations carried out in neighboring countries (Gogala *et al*., 2005;Trilar & Gogala, 2012; Gogala & Trilar unpublished data), we expected to find additional species of cicadas using a bioacoustic approach, and decided to make the first attempt to fill the gap in the knowledge of the distribution of Cicadidae in eastern Europe on our field excursion to Serbia in 2014.

Materials and Methods

Our field trip to Serbia took place between 4 and 12 June, 2014. We were searching for cicadas with bioacoustic equipment on Mt. Avala and in SW Serbia: surroundings of Ivanjica and Zlatibor and around Novi Pazar (Fig. 1).

For acoustic detection and recording of songs we used a Pettersson D-200 (heterodyne system) ultrasonic detector with electret microphones of the same producer (frequency range 10-120 kHz), mounted in front of a Telinga reflector (57 cm diameter) and/or a Renault R-4 front light reflector and connected to the solid state recorders Marantz PMD-660 (sampling rate up to 48 kS) or Zoom H2 (sampling rate up to 96 kS). Due to the high frequency range of many species (Gogala *et al*., 2012), we would not have been able to hear the acoustic signals of these cicada species without the use of ultrasonic detectors, though younger people can hear them over short distances up to 50 m. We used the seewave package (Sueur *et al*., 2008) as a part of the R software platform (R Development Core Team, 2012) to generate spectrograms.

Figure1. An overview map of Serbia with adjacent countries. The red rectangle and red dot (Mt. Avala) show part of the country shown in Figs. 2, 4, 6, 8 and 10 with distributional data.

Song recordings are deposited in the Slovenian Wildlife Sound Archive of the Slovenian Museum of Natural History (PMSL).

The maps were created by the online GPS Visualizer (Schneider, 2003-2016).

Results

In Table I and the maps in Figs. 2, 4, 6, 8 and 10, we present the results of our field investigations. For each species found we also provide typical oscillograms and sonograms of the songs (Figs. 3, 5, 7, 9, 11 and 12). Altogether, we found six cicada species; three of the complex of mountain cicadas (*Cicadetta montana sensu lato*) are the first acoustically confirmed records for Serbia: *C. montana sensu stricto* (Scopoli, 1772), *C. cantilatrix* Sueur & Puissant, 2007 and *C. macedonica* Schedl, 1999.

Also new are the distributional data for the other three registered species: *Cicadivetta tibialis* (Panzer, 1798), *Dimissalna dimissa* (Hagen, 1856) and *Tettigettula pygmea* (Olivier, 1790).

Table I. List of localities with cicadas detected. Names of the localities, dates of visits, geographic coordinates with elevations and list of the cicada species in a particular locality are given. The shortened scientific names of species represent the following taxa:

C. montana - *Cicadetta montana* sensu stricto (Scopoli, 1772)
C. cantilatrix - *Cicadetta cantilatrix* Sueur & Puissant, 2007
C. macedonica - *Cicadetta macedonica* Schedl, 1999
C. tibialis - *Cicadivetta tibialis* (Panzer, 1798)
D. dimissa - *Dimissalna dimissa* (Hagen, 1856)
T. pygmea - *Tettigetula pygmea* (Olivier, 1790)

Locality	Date	Latitude	Longitude	Elevation	Detected taxa
Beograd, Avala	4.6.2014	N44°41.741'	E20°30.753'	444 m	*C. montana*
Ivanjica, Rašići	5.6.2014	N43°37.402'	E20°14.625'	653 m	*C. macedonica*
Đakovo, Studenica	6.6.2014	N43°30.947'	E20°29.809'	548 m	*C. macedonica*
Kraljevo, Ušće	6.6.2014	N43°27.630'	E20°35.872'	395 m	*D. dimissa*
Raška, Brvenica	6.6.2014	N43°20.704'	E20°34.842'	484 m	*C. macedonica*
Radočelo, Rudno	6.6.2014	N43°23.937'	E20°31.131'	807 m	*C. cantilatrix* *C. macedonica*
Radočelo, Rudno	6.6.2014	N43°24.616'	E20°29.850'	1030 m	*C. cantilatrix* *C. macedonica* *C. montana*
Radočelo, Črepulnik	6.6.2014	N43°25.697'	E20°24.330'	1150 m	*C. montana*
Ivanjica, Bedina varoš	7.6.2014	N43°33.544'	E20°11.075'	916 m	*C. montana*
Ivanjica, Kušići	7.6.2014	N43°29.289'	E20°03.782'	1221 m	*C. montana*
Nova Varoš, Bukovik	7.6.2014	N43°25.237'	E19°56.170'	1057 m	*C. cantilatrix* *C. montana*
Nova Varoš, Negbina	7.6.2014	N43°31.692'	E19°48.014'	866 m	*C. cantilatrix*
Zlatibor, Ribnica	8.6.2014	N43°40.938'	E19°39.255'	1058 m	*C. cantilatrix*
Čajetina, Uvac, Stublo	8.6.2014	N43°38.553'	E19°38.098'	1270 m	*C. montana*

Locality	Date	Latitude	Longitude	Elevation	Detected taxa (Table I continued)
Čajetina, Manastir Uvac	8.6.2014	N43°36.800'	E19°35.166'	540 m	*C. cantilatrix* *C. macedonica*
Užice, Milekići	9.6.2014	N43°49.150'	E19°30.424'	803 m	*C. cantilatrix*
Užice, Mokra gora	9.6.2014	N43°47.082'	E19°29.511'	539 m	*C. cantilatrix* *C. macedonica* *C. tibialis*
Užice, Mokra gora, Mantese	9.6.2014	N43°48.963'	E19°28.539'	1108 m	*C. cantilatrix* *C. montana*
Bajina Bašta, Perućac	9.6.2014	N43°57.378'	E19°26.656'	302 m	*C. macedonica* *D. dimissa*
Bajina Bašta, Solotuša	9.6.2014	N43°54.295'	E19°33.623'	931 m	*C. montana*
Prijepolje, Mileševo	10.6.2014	N43°22.069'	E19°43.035'	602 m	*C. cantilatrix*
Prijepolje, Mileševo	10.6.2014	N43°22.323'	E19°42.009'	548 m	*C. macedonica*
Prijepolje, Hisardžik	10.6.2014	N43°21.262'	E19°42.396'	882 m	*C. montana*
Prijepolje, česma - spom. partizanom in italijanom	10.6.2014	N43°19.936'	E19°45.800'	1215 m	*C. cantilatrix* *C. montana*
Prijepolje, Karaula	10.6.2014	N43°19.103'	E19°51.043'	1282 m	*C. cantilatrix* *C. montana*
Novi Pazar, Pavlje (Osaonica)	10.6.2014	N43°10.297'	E20°21.440'	733 m	*C. cantilatrix*
Novi Pazar, Sebećevo	11.6.2014	N43°06.548'	E20°25.068'	653 m	*C. macedonica*
Tutin, Batrage	11.6.2014	N42°56.218'	E20°24.291'	817 m	*C. cantilatrix*
Tutin, Batrage	11.6.2014	N42°56.053'	E20°24.194'	755 m	*C. cantilatrix*
Tutin, Ribariće	11.6.2014	N42°57.627'	E20°25.595'	772 m	*C. cantilatrix*
Raška, Karadak	11.6.2014	N43°15.030'	E20°40.141'	427 m	*T. pygmea* *D. dimissa*
Raška, Lisina	11.6.2014	N43°16.607'	E20°45.496'	1274 m	*C. macedonica* *C. montana*
Tutin, Orlje	12.6.2014	N43°00.850'	E20°25.158'	1128 m	*C. montana*
Tutin, Paljevo	12.6.2014	N43°01.228'	E20°24.667'	1138 m	*C. montana*
Tutin, Naboje	12.6.2014	N43°00.678'	E20°13.147'	1404 m	*C. cantilatrix* *C. montana*
Tutin, Ramoševo, Jarut	12.6.2014	N43°05.605'	E20°13.154'	1174 m	*C. montana*
Novi Pazar, Sopoćani	12.6.2014	N43°07.052'	E20°22.600'	740 m	*C. cantilatrix* *C. macedonica* *C. montana*
Novi Pazar, Trnava	12.6.2014	N43°06.821'	E20°33.273'	601 m	*C. macedonica* *T. pygmea*
Novi Pazar, Postenje	12.6.2014	N43°10.926'	E20°32.539'	480 m	*C. macedonica*

Discussion

Probably the first important contribution to the fauna of cicadas of Serbia was published by Geza Horvath (1903). He listed six species from Belgrade and its surroundings: *Tettigia* (now *Cicada*) *orni* Linnaeus, 1758, *Tibicen* (now *Tibicina*) *haematodes* (Scopoli, 1763)*, C. montana, C. brullei* (Fieber, 1876) (now *Tettigettula pygmea* (Olivier, 1790)) *C. tibialis* and *Cicadetta* (now *Pagiphora*) *annulata* (Brullé, 1832) from Niš.

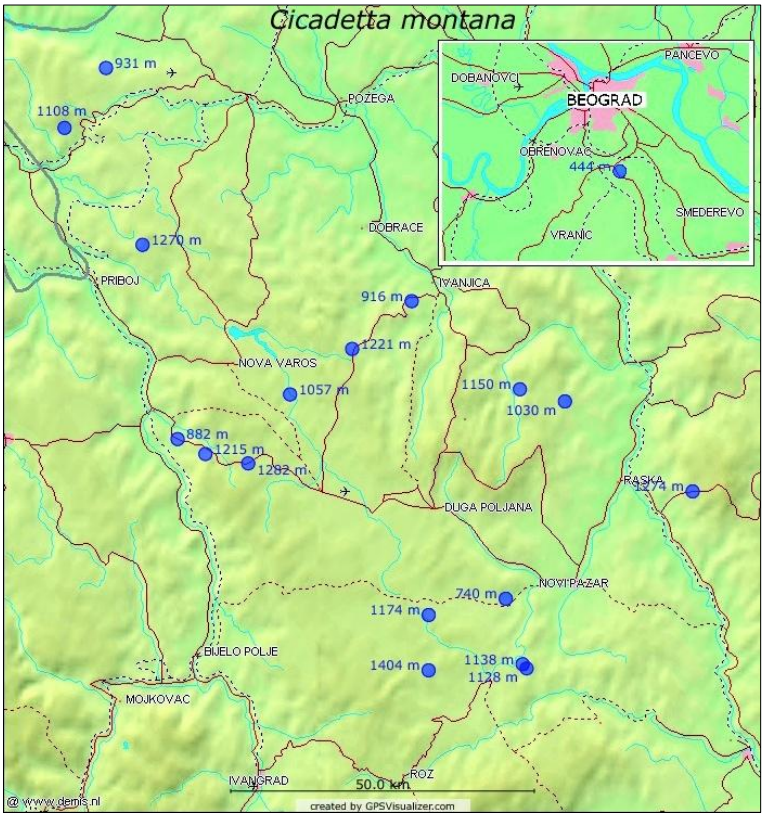

Figure 2. New localities for *Cicadetta montana* s. str. in Serbia with elevation data. Locality on Mt. Avala is shown in the insert.

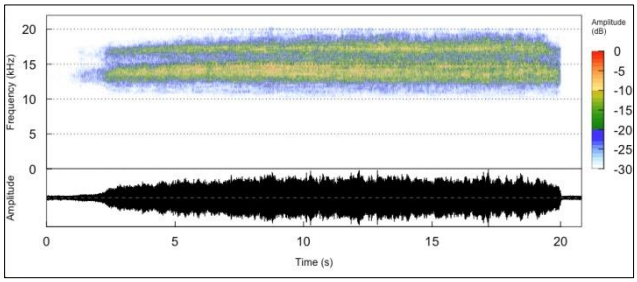

Figure 3. Oscillogram (below) and sonogram (spectrogram) of *Cicadetta montana* s. str. from Mt. Avala.

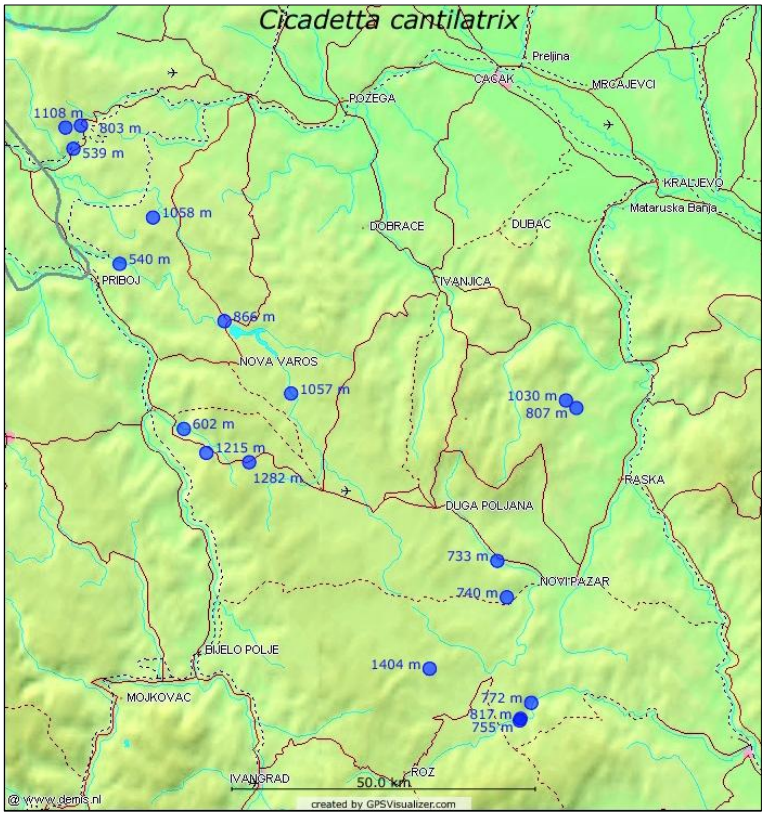

Figure 4. Localities for *Cicadetta cantilatrix* with elevation data.

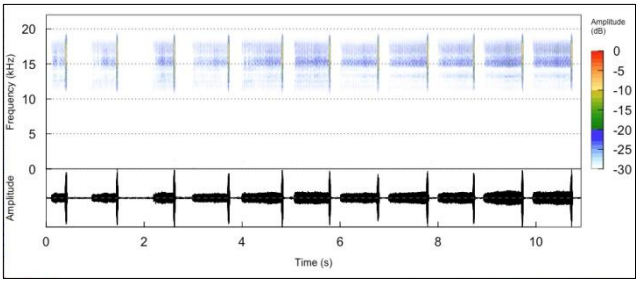

Figure 5. Oscillogram and sonogram of the calling song of *Cicadetta cantilatrix* from Mt. Radočelo.

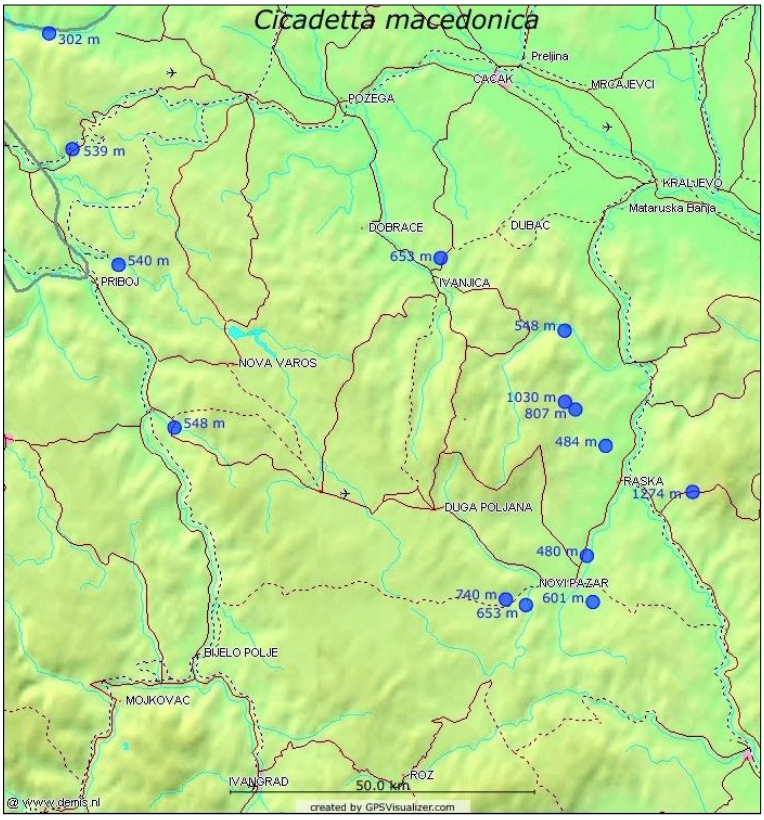

Figure 6. Localities of the *Cicadetta macedonica* with elevation data.

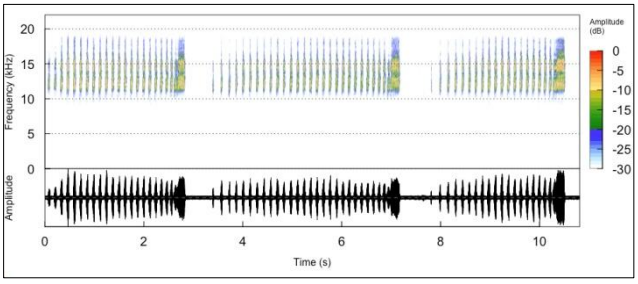

Figure 7. Oscillogram and sonogram of *Cicadetta macedonica* from Ivanjica, Rašići.

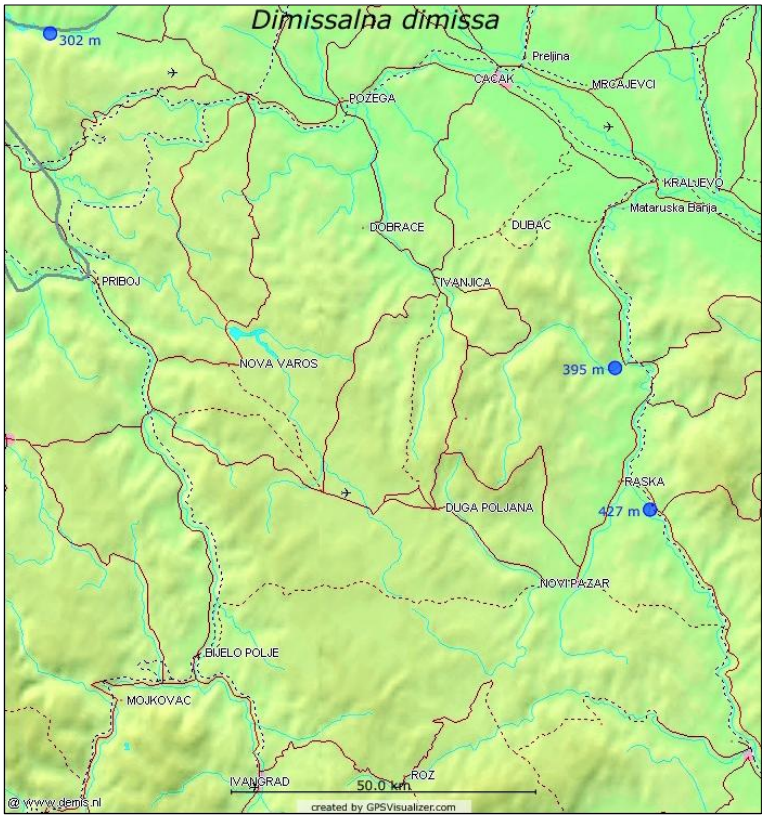

Figure 8. Localities of *Dimissalna dimissa* with elevation data.

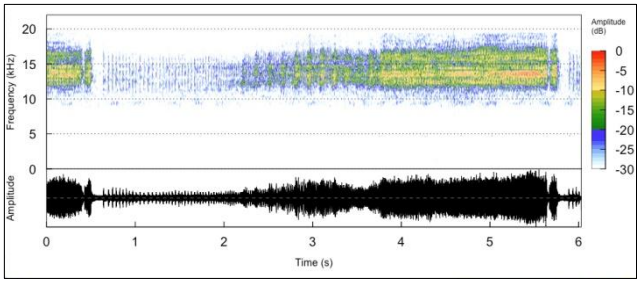

Figure 9. Oscillogram and sonogram of *Dimissalna dimissa* from Bajina Bašta, Perućac.

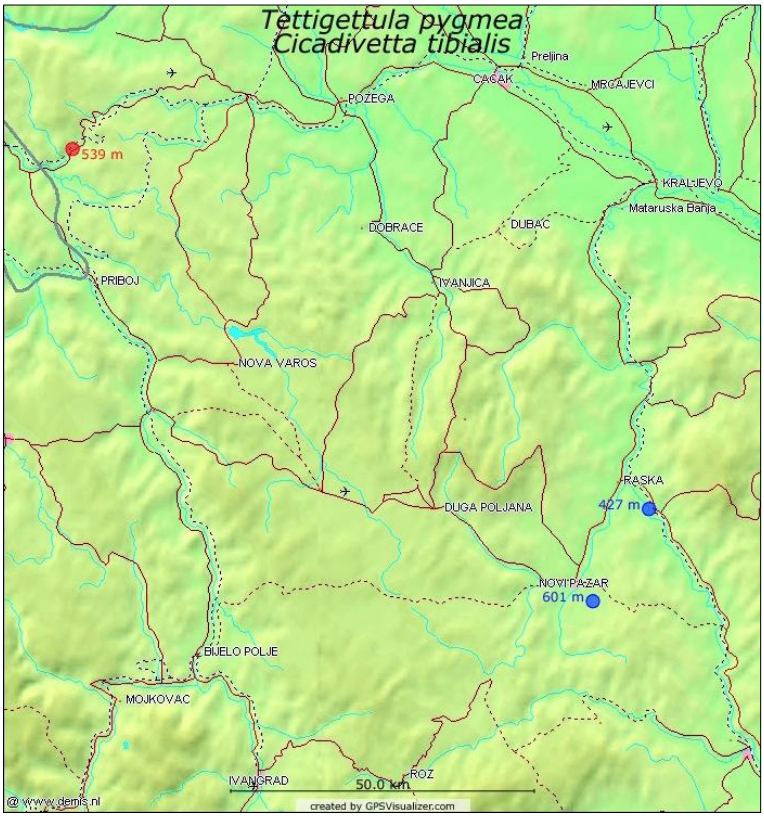

Figure 10. Localities of *Tettigettula pygmea* (blue) and *Cicadivetta tibialis* (red) with elevation data.

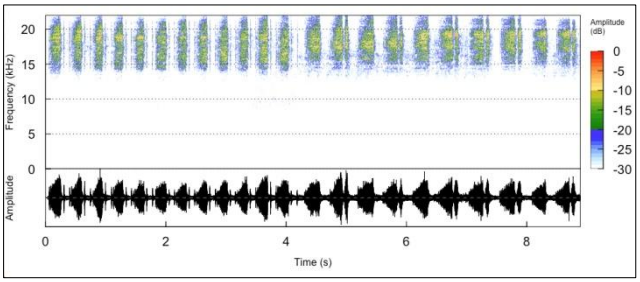

Figure 11. Oscillogram and sonogram of the calling song of *Tettigettula pygmea* (type 1) from Kaznoviće (Raška).

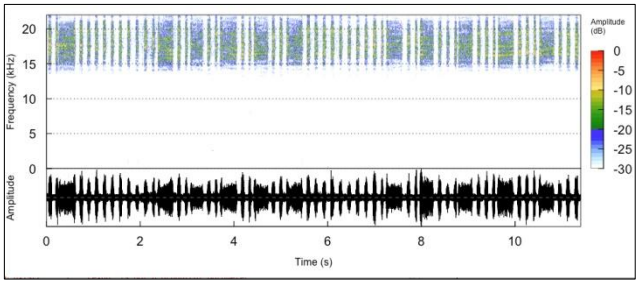

Figure 12. Oscillogram and sonogram of the calling song of *Cicadivetta tibialis* from Kotroman (Mokra Gora).

Later, most papers about the fauna of cicadas of Serbia were written by Ljubodrag Janković (1962, 1966, 1975, 1976), and the importance of some species as pests were presented by M. Lekić (1967a, b). Janković (1975) added *Tibicen* (=*Lyristes*) *plebejus* (Scopoli, 1763), *Cicadatra atra* (Olivier, 1793) and *Cicadetta* (now *Dimissalna*) *dimissa* to the species mentioned above. The same author (Janković, 1978) mentions the presence of 11 species of Cicadidae for Yugoslavia but does not list them.

Cicadetta montana was reported previously from Fruška Gora (Janković, 1976), but due to the present knowledge of this taxon (Gogala & Trilar, 2004; Gogala, 2013) and without any acoustic data, we cannot decide which sister species of the mountain cicada complex (*C. montana s. l.*) exists there.

From this complex, we found and confirmed during our field studies the following three species: *Cicadetta montana s. str.*, *C. cantilatrix* and *C. macedonica.*

According to the distributional data in neighboring countries of Croatia (unpublished data), Hungary (Trilar & Gogala, 2012), Romania (Trilar *et al*., 2006; Trilar & Gogala, 2008), Macedonia (Gogala *et al*., 2005, 2014) and Bulgaria (unpublished data), one could expect to find *C. brevipennis* Fieber, 1876 and possibly *C. concinna* Germar, 1821 in Serbia.

For the species *Dimissalna dimissa, Cicadivetta tibialis* and *Tettigettula pygmea,* found during our field excursion, we have contributed new distributional data.

We undertook our field excursion early in the season, and therefore did not expect and indeed did not detect or collect some other common cicada species, such as *Cicada orni*, *Lyristes plebejus, Tibicina haematodes, Cicadatra atra* or *Pagiphora annulata.*

Acknowledgements

This paper is dedicated to the late Prof. Dr. Božidar Ćurčić who passed away just a few days before we submitted this paper. He stimulated our research and gave us good and useful suggestions as to where to start our investigations of the Serbian cicada fauna. Our field research was supported by the Slovenian Museum of Natural History and Slovenian Academy of Sciences and Arts. The research of the second author

(TT) was part of the program “Communities, relations and communications in the ecosystems” (No. P1-0255) financed by Ministry of Education, Science and Sports of the Republic of Slovenia.

We are grateful for very useful comments and suggestions by both reviewers, Thomas Hertach and Stéphane Puissant.

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ПРВА БИОАКУСТИЧКА ИСТРАЖИВАЊА ПЕВАЈУЋИХ ЦИКАДА (HEMIPTERA: CICADIDAE) У СРБИЈИ

МАТИЈА ГОГАЛА и ТОМИ ТРИЛАР

Извод

Истраживали смо распрострањење певајућих цикада у Србији са биоакустичким приступом. У југозападној Србији и на Авали смо у периоду од 5. до 12. јуна 2014. године установили присуство шест врста. Три врсте су нове за Србију - *Cicadetta montana* sensu stricto, *C. cantilatrix* и *C. macedonica*. Друге три врсте - *Dimissalna dimissa, Cicadivetta tibialis* и *Tettigettula pygmea* пронашли смо на новим локалитетима.

Received November 27th, 2015
Accepted February 25th, 2016