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LJUBLJANA, JULY 1998 Vol. 6, No. 1: 5-15

FIRST RECORD OF *CICADATRA PERSICA* KIRKALDY, 1909 FROM MACEDONIA, WITH DESCRIPTION OF ITS SONG

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Abstract - *Cicadatra persica* Kirkaldy, 1909, has been found for the first time in Macedonia (UTM squares DL79 and DM61) and also in the Balkans. It had been previously reported from Iran, the Caucasus, Asia Minor and from the Mediterranean island Sicily. We recorded and analyzed the song of this species. Its continuous song is similar to other *Cicadatra* species with the main frequency range between 6 and 12 kHz. The courtship song, often sung in metachronous (nearly simultaneous) manner with the neighboring males, consists of 5 7 s long repeated phrases, each composed of a long series (N = 59±14) of wing clicks (rep. frequency about 11 Hz) produced during wing flipping, interrupted once in a phrase by a short 0.19 s tymbal echeme. A similar combination of two independent sound producing mechanisms has also been described in the courtship songs of some other *Cicadatra* species, and in several other genera in other parts of the world.

Izvleček - PRVA NAJDBA ŠKRŽATA *CICADATRA PERSICA* KIRKALDY, 1909, V MAKEDONIJI IN OPIS NJEGOVIH NAPEVOV

Škržate vrste *Cicadatra persica* Kirkaldy, 1909, smo našli v Makedoniji v dolini Radike in Garske reke (UTM kvadrati DL79 in DM61), kar je prva najdba v Makedoniji in na Balkanu. Ta vrsta je sicer razširjena v Iranu, na Kavkazu, v Mali Aziji, Siriji, Izraelu in na Siciliji. Posneli smo napeve te vrste in jih analizirali. Neprekinjeni napev je podoben kot pri drugih vrstah rodu *Cicadatra* in obsega frekvenčni pas od 6 do 12 kHz. Napev dvorjenja, pri katerem pojejo sosednji samci pogosto skoraj sočasno z majhnim zamikom, sestoji iz ponavljajočih se fraz dolžine okoli

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5 do 7 s. Vsaka fraza sestoji iz serije hitro ponavljajočih se pokov (N = 59±14, ponavljalna frekvenca okoli 11 Hz), ki verjetno nastanejo ob udarjanju s krili ob telo, in enega timbalnega ehema dolžine približno 0,19 s. Podobna kombinacija dveh načinov oglašanja je znana tudi pri napevih dvorjenja nekaterih drugih vrst rodu *Cicadatra* in pri nekaterih drugih rodovih škržatov iz drugih delov sveta.

Introduction

During bioacoustic field work in Macedonia on July 10th, 1996, in the valley of the Garska river near Osoj and the bridge Jelenski Skok we heard and recorded a continuous acoustic signal reminescent of the songs of some cicadas of the genus *Cicadatra*. During this excursion we were not able to catch and identify the singing insect. Approximately one year later we came again to the same spot near the bridge Jelenski Skok and to Radika Gorge, and heard again the same signal and also another type of song at the same spot. This time we succeeded in not only recording the signals but also observing and catching the animals. They all belonged to a species, *Cicadatra persica* Kirkaldy, 1909, previously unknown from this region (KUDRYASHEVA, 1979). Its sound signals are described here for the first time.

Material and Methods

The songs of the cicadas were detected and recorded by various methods.

One method for sensitive detection of high pitched sounds used in this study was the use of an ultrasonic microphone mounted on a Telinga parabola, connected to a bat detector S-25 Ultra Sound Advice in combination with a DAT tape recorder. This system was described by POPOV et al. (1997).

The standard recordings in the human sonic range were made using two Telinga microphones, a Telinga stereo Pro 3 microphone and a mono Pro 3 mike in connection with DAT recorders SONY TCD-D3, TCD-D7 or TCD-D10.

Some recordings in the summer 1997 were made with a new ultrasonic Telinga Pro 5 Science microphone and a High Speed (HS) DAT recorder Pioneer D-C88 (sampling rate 96 kHz/s) covering the frequency range of 5 - 44000 Hz.

In the lab., DAT recordings were transferred to the hard disk of a Macintosh PowerPC 8500/120, or more recently to a Power Macintosh G3/233 computer through an Audiomedia III card. Software used for viewing, editing and analyzing the song signals were Digidesign ProTools 3.0 and 4.0, and Canary 1.2.

Identification of the specimens as *Cicadatra persica* Kirkaldy, 1909, was made by Dr. W. Schedl, Innsbruck. The specimens are preserved in the Hemiptera collection of the Slovenian Museum of Natural History (PMSL), Ljubljana, Slovenia. The specimens have been labeled: Osoj, Garska r., Jelenski skok, 19. 6. 1997, UTM: DL79 (1 male) and Vrbjani, Radika r., 19. 6. 1997, UTM: DM61 (1 male, 1 female).

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Results

In 1997 we made field recordings in the valley of the Garska river near the bridge Jelenski Skok (UTM coordinates DL79, 800 m a.s.l.) and in the region of the Radika Gorge near the village Vrbjani (UTM coordinates: DM61, cca 900 m a.s.l.) on June 19th (Fig. 1 b). We heard and recorded near the bridge two types of songs described below in more detail. We were able to see, catch and videographically record singing cicadas. In a similar biotope a few kilometers away in the Radika Gorge near the village Vrbjani we found another population of these cicadas that were singing and courting on smaller trees on slopes above the river bed. Here we caught some specimens and made additional recordings.

Based on morphological characteristics, it was quite obvious that these specimens were close to three other *Cicadatra* species occurring in Macedonia: *Cicadatra atra* (Olivier, 1790), *C. hyalina* (Fabricius, 1798), and *C. hyalinata* (Brullé, 1832). Later this same year, Dr. Wolfgang Schedl, Innsbruck, showed us during our visit there comparative material of this species and identified our specimens as *Cicadatra persica*. We compared our specimens also with the rich material from Turkey, preserved in the collection of the Institute of Systematics and Population Biology (Zoological Museum) in Amsterdam. The distribution of this species ranges, according to the Russian specialist KUDRYASHEVA (1979), to the data in METCALF (1962, 1963) and DUFFELS & VAN DER LAAN (1985), from Iran, the Caucasus and Asia Minor to Syria, Israel and Sicily. According to these authors it is unknown from Greece and other parts of the Balkans including Macedonia.

Some morphological characteristics such as the enlarged and curved front vein of the tegmina, the bluish hue of wings due to the Tyndall effect, and a tymbal with 10 long ribs, are evident from Fig. 1 a, c and d.

We were able to record two clearly different types of song, a continuous one, similar to the continuous song of *Cicadatra atra* or *C. hyalina*, and a courtship song produced obviously by a combination of wing clicking and tymballing echemes, which is also typical for courtship songs of some other *Cicadatra* species (BOULARD, 1995).

All together we evaluated 11 recordings of continuous songs and 7 recordings of courtship songs (the duration of selected sequences was 30 - 35 s). All recordings were made at ambient temperatures from 29 to 33°C.

Continuous song: Phrases can last without interruption for many minutes. The frequency range is between 5.8 and 12.4 kHz (-20 dB) with a maximum amplitude near 8.4 kHz (Figs. 2a,b). In this broad frequency band there are many small frequency peaks as seen in the spectrograms and sonograms. They are 670 - 1300 Hz apart due to the ultrastructure of this song, which consists of pulses, tymbal rib clicks with a repetition period of about 0.8 to 1.5 ms (repetition frequency 670 1250 Hz) (compare GERHARDT, 1998).

This song starts without any distinct pattern of amplitude modulation and ends sometimes with one or a few separate, irregular echemes.

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Courtship[1] song: The phrases of this song consist of long series of rapidly repeated wing clicks (mean repetition period 89±15 ms), which end with a loud tymbal echeme with increasing amplitude (duration 186±26 ms, Figs 3 and 4). The mean period duration of such repeating phrases is 6±1.3 s. After a short pause (Fig. 3) the wing clicks of the next phrase start again. The first interval between clicks is usually somewhat longer and the last 2 - 6 intervals in a phrase are prolonged even more (e.g. Fig. 4f). Therefore, we excluded these values in the statistical evaluation of interval duration (Fig. 4c). The interval between the last click and a tymbal echeme is extremely variable and can last between 60 and 600 ms. The average number of wing clicks in a phrase is 59±14 (Fig. 4e). The frequency spectrum of tymbal echemes is similar to the spectrum of a continuous song (see above), but the wing clicks have, as expected, a broader frequency spectrum (2 - 20 kHz) with a maximum amplitude between 3 and 7 kHz (Fig. 3a,b).

Animals singing close to each other often nearly synchronize phrases so that tymbal echemes appear almost simultaneously but are slightly shifted for about 50 - 150 ms (Fig. 3d).

In addition to these two types of song, we recorded a few irregular tymbal echemes with the same spectrum as the continuous song, usually before the cicadas flew away (disturbance sounds of animals singing or courting too close to each other? - Fig. 5).

During this field trip we were not able to observe the details of wing click production, or crepitation, and this phenomenon should therefore be studied more thoroughly in the future.

Discussion

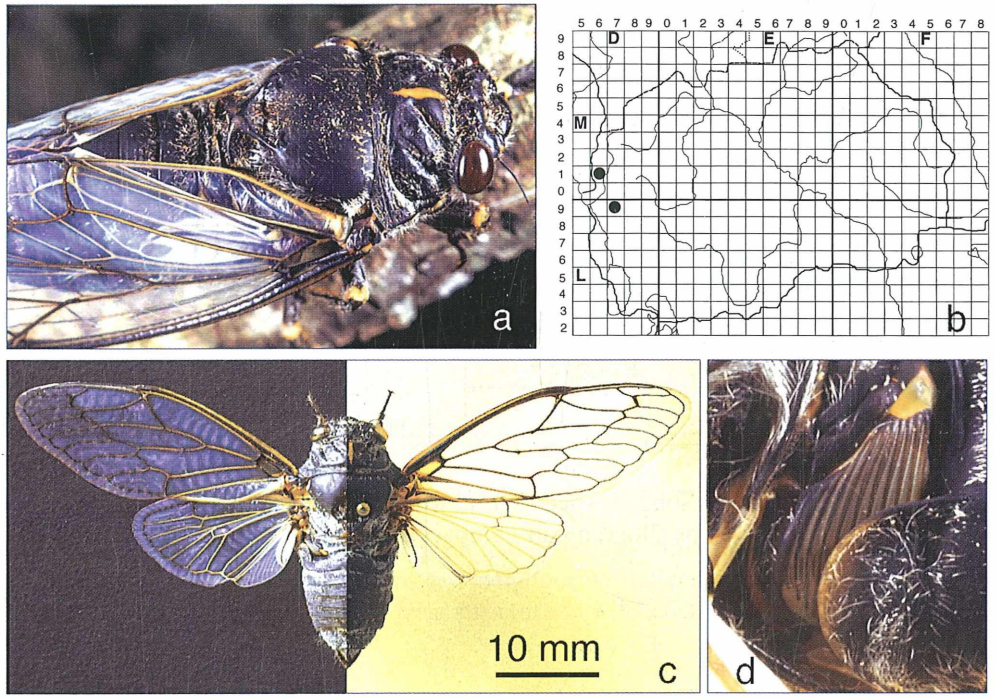
Comparison of the songs of *Cicadatra persica* to sound emissions of other *Cicadatra* species is instructive. It is evident that many species of this genus combine in the courtship song the normal tymbal sounds with clicks produced by wing banging against the body or substrate. These clicks were first reported in some North American cicadas which lack tymbals (e.g. *Neoplatypedia constricta* Davis) and in tymballing plus crepitating or stridulating cicadas in North and South America, Australia, and New Zealand by MOORE (1968, 1973), in calling songs of New Zealand cicadas of the genus *Amphipsalta* (DUGDALE and FLEMING, 1969), and in courtship sounds of *Okanagana rimosa* (Say, 1830) in North America (HUBER et al., 1980). Another case of such crepitation sounds produced by wing clicking has been reported also by DUFFELS (1988) for *Aceropyga pterophon* Duffels, 1988 from the Fiji Islands. Among the palaearctic species such sound production was described by POPOV (1981) in *Cicadetta sinuatipennis* Oshanin, 1906 and Boulard later studied this behavior in more detail in *Cicadatra atra* Olivier, 1790 (BOULARD, 1992, 1995 and BOULARD & MONDON, 1995). Such sound emissions were also reported for *C. glycirrhizae* (Kolenati, 1857)(see BOULARD, 1995), and now also for *C. persica*. A common morphological characteristics of these species

[1] We are following here a terminology of M. Boulard (1995), in contrast to A. V. Popov (1975), who uses for similar songs in cicadas of the genus *Cicadatra* a term calling song.

is a thickened costal rsp. radial vein on the front wings. Sounds are produced by females, using the same wing mechanisms as males, in some crepitating and stridulating cicadas (MOORE, 1973).

In contrast to *C. atra* or *C. glycirrhizae*, the courtship song of *C. persica* differs in the high number of wing clicks, repeated extremely rapidly (repetition frequency 11 Hz) and interrupted only after many seconds by a short echeme produced by tymbals. We were not able to analyze this sound production in detail during our field work, but observed the movement of wings in the same rhythm as the clicks which were heard and recorded.

During the same excursion we recorded songs of *Cicadatra hyalina*, which is abundant in some regions of Macedonia. In these recordings there are sound elements similar to the wing clicking of *C. persica* courtship songs. However, neither POPOV (1975) nor BOULARD (1995) mention wing clicking in this species.



1: Some morphological characteristics of *Cicadatra persica* Kirkaldy, 1909. a) live specimen, sitting on a branch, b) map of Macedonia with UTM grid 10 x 10 km and localities marked, c) specimen from the collection, left side photographed above a dark background to show characteristic bluish hue on wings, and right side above a light background to show thickened and curved radial vein, d) left tymbal with 10 long ribs.

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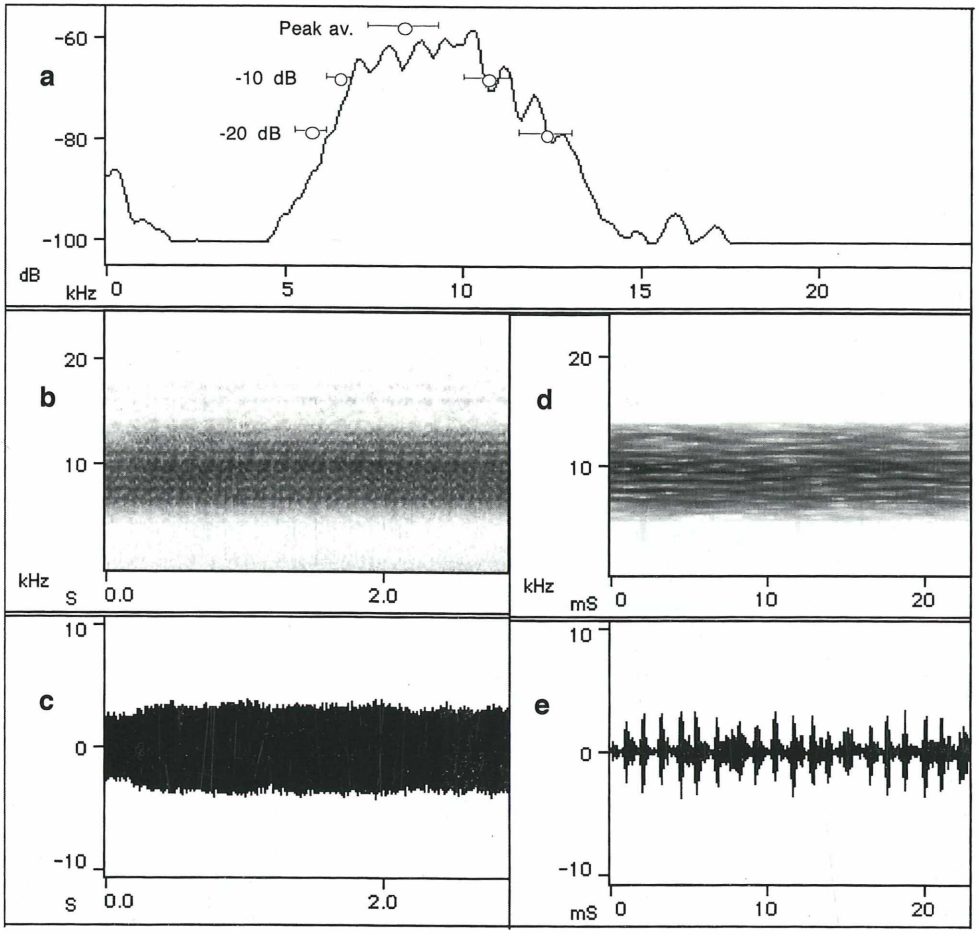
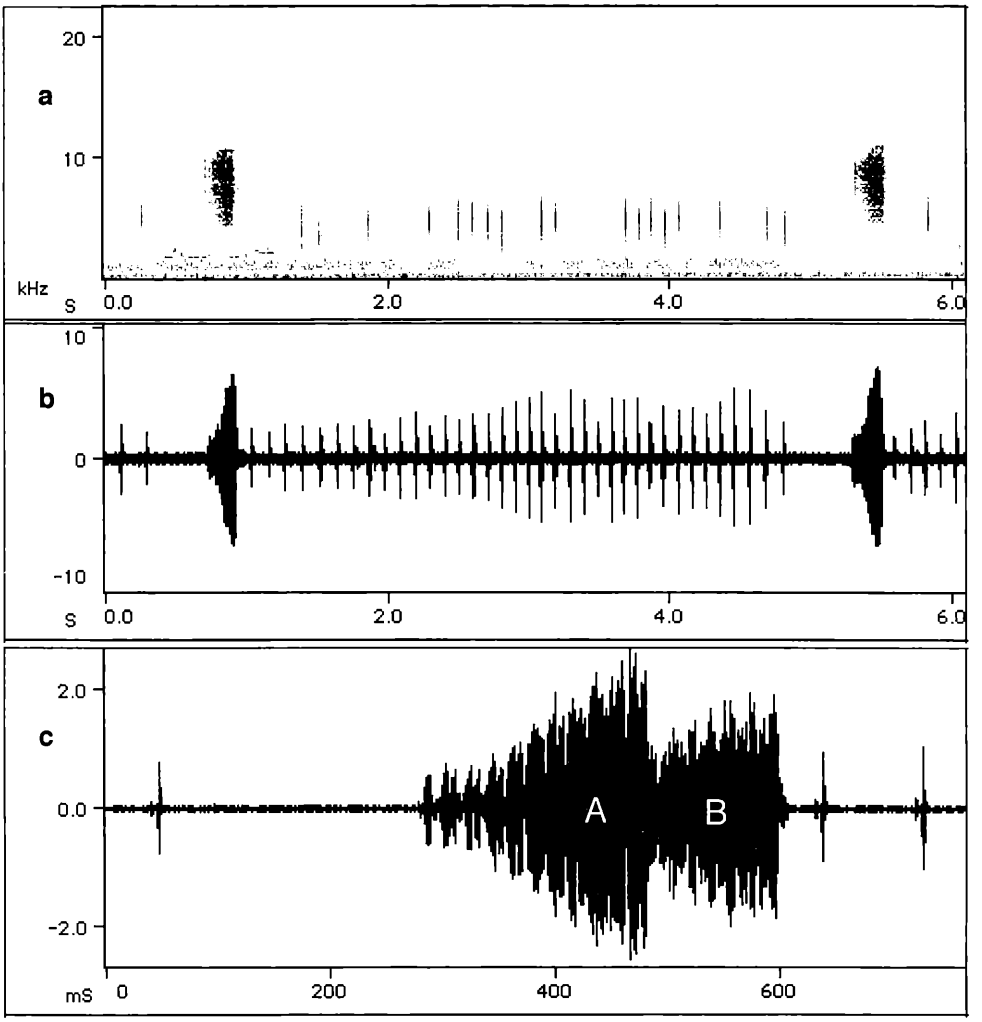


2: ***C. persica*** - continuous song. a) spectrogram with statistical data for 7 animals, b and d) sonograms, c and e) oscillograms in compact and extended time scales from the same selection.



3: ***C. persica*** - courtship song: a) sonogram and b) oscillogram of a 6 s long selection, c) example of metachronous singing of two neighboring males (A, B) in extended time scale to show also the usual double click structure of wing clicks.

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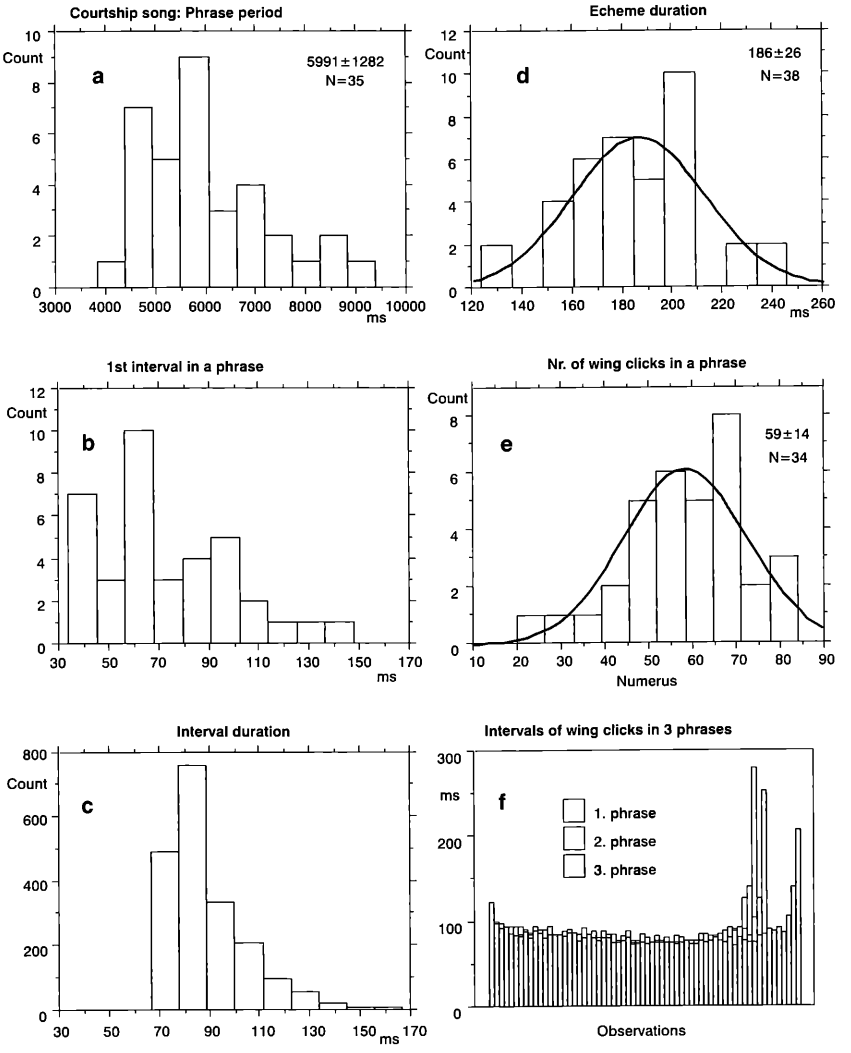
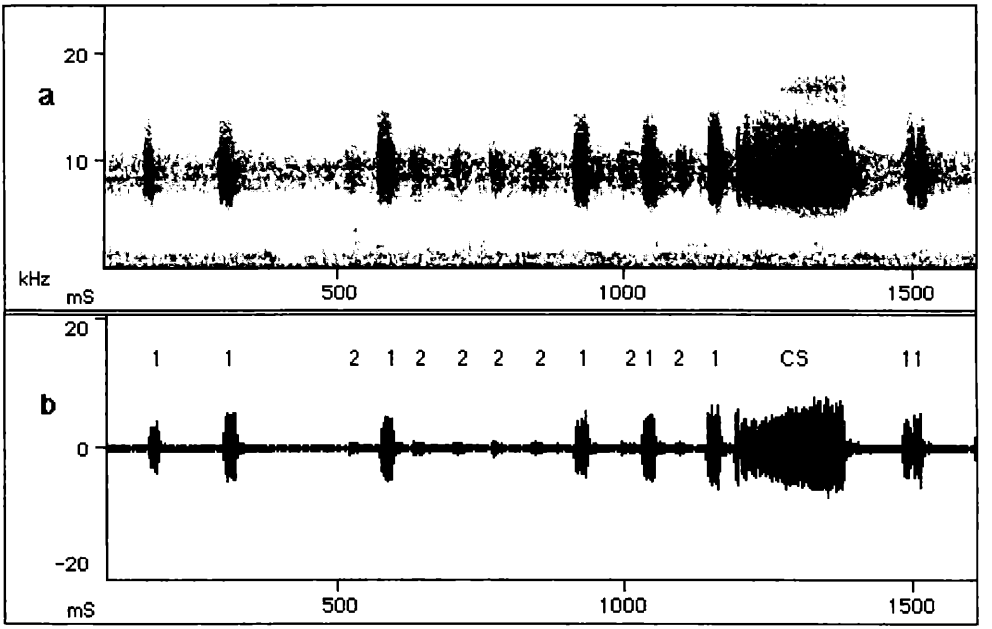


4: ***C. persica*** time parameters of the courtship song: a) Histogram of phrase period duration, b) length of interval between the end of a tymbal echeme and the first wing click in a phrase, c) interval duration between wing clicks - the first and up to 6 last intervals in a phrase are excluded from the analysis (for reason see text and Fig. 4f), d) tymbal echeme duration, e) number of wing clicks in a phrase, f) duration of progressive single intervals between wing clicks in three subsequent phrases, showing prolonged intervals at the beginning and especially at the end of phrases. Sample sizes, means, and standard deviations are shown in a-e.



5: Example of short, irregular tymbal echemes in two animals (1, 2) with unknown biological meaning (disturbance sound, alternation?; see text), interrupted with the tymbal echeme of the courtship song (CS); animal 1 closer to the microphone than animal 2; a, sonogram, b, oscillogram.

The continuous song is similar among several *Cicadatra* species.

The geographic distribution of *C. persica* shown in KUDRYASHEVA (1979), together with our new localities suggests the likelihood that this species also is present in Greece, Albania, or possibly in some other parts of the Balkans. In future field work one should use acoustic equipment similar to ours (POPOV et al., 1997) and look in similar biotopes, such as in the gorges of the Radika and the Garska River, to determine the real distribution of this species.

Acknowledgments

Our field work in Macedonia in 1996 and 1997 was financially supported by the Ministry of Culture of the Republic of Slovenia. In Macedonia, we received full support by the former and present directors of the Natural History Museum in Skopje Dr. Zorka Georgievska and Dr. Svetozar Petkovski. The most important help during our work and stay there was offered by our colleagues and friends Vlado Krpać and Toše Ivanovski. For identification of the specimens we are grateful to Prof. Dr. Wolfgang Schedl from Innsbruck and for additional information on wing banging or clicking to Prof. Thomas E. Moore from Ann Arbor, Michigan and to Dr. Hans Duffels from Amsterdam, who also read the manuscript and suggested many improvements.

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Zeitschrift/Journal: Acta Entomologica Slovenica

Jahr/Year: 1998

Band/Volume: 6

Autor(en)/Author(s): Gogala Matija, Trilar Tomi

Artikel/Article: First record of Cicadatra persica Kirkaldy, 1909 from Macedonia, with Description of its song. 5-15