

## SONG DESCRIPTION OF ZUBOVSKI'S BUSH-CRICKET, *ISOPHYA ZUBOWSKII* (ORTHOPTERA: PHANEROPTERIDAE)

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**Abstract.** The bush-cricket *Isophya zubowskii* Bey-Bienko, 1954 was surveyed in the period 2002-2012 in 11 locations from Romania. The calling song, described hereby for the first time, consists of a long series of syllables, each formed by 85-118 impulses and lasting for 236-319 ms in the populations near Iași, while the individuals from three other populations in Southern Romania produce shorter syllables, consisting of 74-105 impulses and, lasting for 182-251 ms. Sound frequency ranges in the interval 10-40 kHz, with highest peak at about 18-26 kHz. Based on the description of its calling song, we conclude that *Isophya zubowskii* belongs to the *Isophya kraussii* species group.

**Résumé.** La sauterelle *Isophya zubowskii* Bey-Bienko, 1954 a été surveillée pendant 2002-2012 dans 11 différents localités de Roumanie. La stridulation d'*Isophya zubowskii*, décrite ici pour la première fois, se compose d'une longue série de syllabes, chacune formée par 85-118 impulsions et d'une durée de 236-319 ms dans les populations situées près d'Iași, tandis que les individus de trois autres populations du sud de la Roumanie produisent des syllabes plus courtes, composé de 74-105 impulsions, d'une durée de 182-251 ms. La fréquence d'émission sonore est située dans l'intervalle 10-40 kHz, avec la fréquence du maximum d'énergie entre 18-26 kHz. Sur la base de la description de son chant d'appel, nous concluons qu'*Isophya zubowskii* appartient au groupe d'espèces *Isophya kraussii*.

**Key words:** *Isophya*, bioacoustics, Romania, distribution.

### INTRODUCTION

Genus *Isophya* is one of the biggest of Palaearctic Orthoptera, with 89 species known so far and 45 species present in Europe (Eades et al., 2012). Most of the *Isophya* species occur in Southern and Eastern Europe, the Caucasus and Asia Minor, the last one being considered the radiation center of the genus (La Greca, 1999). Many of them have small distribution ranges with specific topographic and habitat affinities (Bauer & Kenyeres, 2006; Sevgili et al., 2006).

Within the genus, several groups of sibling species were identified (Heller, 1988; Sevgili et al., 2006; Warchałowska-Śliwa et al., 2008; Chobanov, 2009). The genus represents a taxonomic challenge for specialists because species identification within these groups is hampered by the similarity in morphological traits and lack of sclerotized genitalia (Heller et al., 2004; Warchałowska-Śliwa et al., 2008). The most utilized tool for discriminating *Isophya* sympatric taxa and disentangling taxonomic relations is the study of males' song patterns (Heller, 1988; Sevgili, 2003; Heller et al., 2004; Orci et al., 2010). The examination of acoustic signals can also provide information on phylogenetic relationship between species (Chobanov, 2009) and helps in the detection of elusive individuals in the field (Orci et al., 2010).

*Isophya zubowskii* occurs in Eastern and Southern Romania, Republic of Moldova and Ukraine (Heller, 2012). The bush-cricket inhabits sunny mesophilic grasslands, forest ecotone and clearings, usually preferring broad-leaved dicotyledonous plants. The most appropriate habitat conditions for this bush-cricket are steppic and forest steppic areas located in Prut River Basin, Eastern Siret River

Basin, Northern Dobrogea and Romanian Plain. First larvae are to be found in April, while imagoes develop in late May and June (Iorgu & Iorgu, 2008).

Although there are many papers that describe the acoustic signals of various *Isophya* species, several taxa remain with the song features unknown, including *Isophya zubowskii* Bey-Bienko, 1954. The aim of the present study is to describe the calling song pattern of *I. zubowskii* from several populations occurring in Romania.

#### MATERIAL AND METHODS

The specimens were caught alive in the wild and transported in plastic recipients. The individuals have been identified using the keys of Kis (1976) and Harz (1969). The Scanning Electron Microscope (SEM) pictures were made with a Tescan Vega SEM at "Al. I. Cuza" University of Iași, after coating the specimens with gold in an EMS 550X sputter coater. For the bioacoustic study, males and females have been recorded indoors, using the digital recorders Sony ICD SX56 and EDIROL R-09HR. Wing movements during the song have been video recorded with a Canon EOS digital camera, equipped with a 100 mm 1:1 macro lens. Song terminology follows Ragge & Reynolds (1998) and Heller et al. (2004). The oscillographic and spectrographic analyses of sound were made with Audacity 1.3.

#### RESULTS AND DISCUSSIONS

Order Orthoptera  
Suborder Ensifera  
Family Phaneropteridae

#### *Isophya zubowskii* Bey-Bienko, 1954

*Examined material.* 5 ♂♂, 5 ♀♀, 05.06.2002, Botanical Garden, Iași, Iași county, 47°11'11.45"N, 27°33'06.56"E, 101 m a.s.l. (leg. I. Șt. Iorgu); 6 ♂♂, 4 ♀♀, 29.05.2005, Valea lui David, Iași county, 47°11'42.61"N, 27°28'06.96"E, 106 m a.s.l. (leg. I. Șt. Iorgu); 15 ♂♂, 11 ♀♀, 31.05.2005, Bârnova forest, near Curățuri, Iași county, 47°01'09.86"N, 27°33'33.77"E, 141 m a.s.l. (leg. I. Șt. Iorgu); 3 ♂♂, 2 ♀♀, 04.06.2007, Bârnova forest, near Poiana cu Cetate, Iași county, 46°59'11.85"N, 27°35'04.07"E, 344 m a.s.l. (leg. I. Șt. Iorgu); 2 ♂♂, 1 ♀, 18.06.2007, Botanical Garden, Iași (leg. I. Șt. Iorgu); 2 ♂♂, 3 ♀♀, 30.05.2008, Valea lui David (leg. I. Șt.



Fig. 1 - a, *Isophya zubowskii*, habitus ♂; b, *Isophya zubowskii*, habitus ♀ (Comana, 25.06.2010; photos: I. Șt. Iorgu).

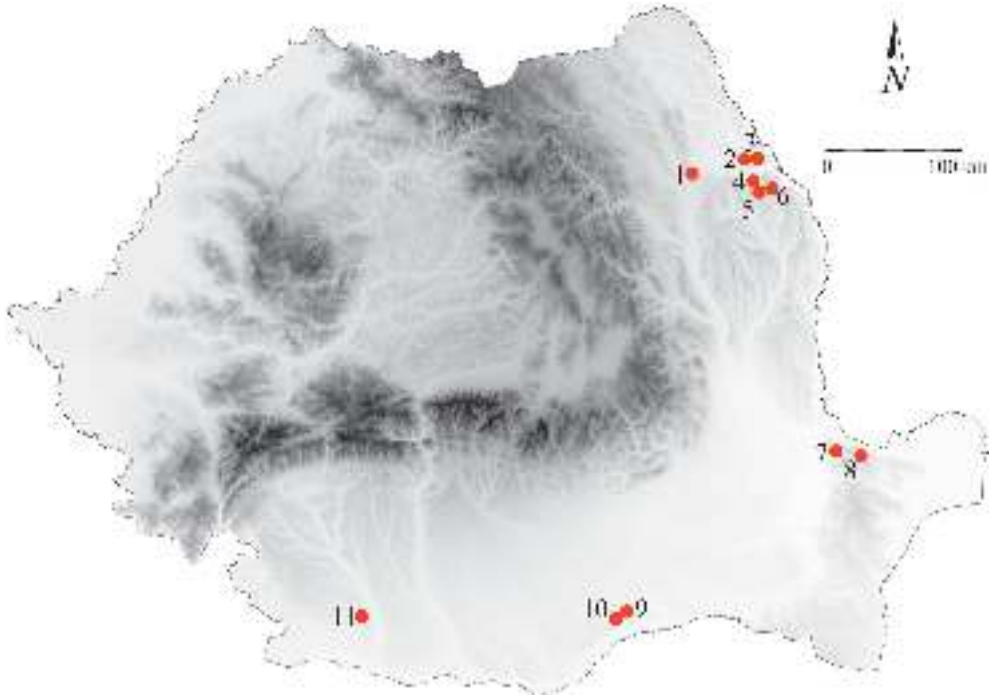


Fig. 2 - Occurrence records of *Isophya zubowskii* in Romania: 1, Miclăușeni; 2, Valea lui David; 3, Botanical Garden Iași; 4, Curățuri; 5, Poiana cu Cetate; 6, Dobrovăț; 7, Greci; 8, Niculițel; 9, Comana; 10, Vlad Țepeș; 11, Cobia.

Iorgu & E. I. Iorgu); 1 ♂, 1 ♀, 17.06.2008, Botanical Garden, Iași (leg. I. Șt. Iorgu); 8 ♂♂, 9 ♀♀, 30.05.2009, Bârnova forest, near Poiana cu Cetate (leg. I. Șt. Iorgu); 1 ♂, 15.06.2009, Comana forest, near Vlad Țepeș, Giurgiu county, 44°08'29.27"N, 26°07'23.84"E, 86 m a.s.l. (leg. E. I. Iorgu); 11 ♂♂, 5 ♀♀, 19.05.2010, Comana forest, near Comana, Giurgiu county, 44°10'16.11"N, 26°11'26.30"E, 68 m a.s.l. (leg. I. Șt. Iorgu); 3 ♂♂, 1 ♀, 27.05.2010, Cobia forest, near Calopăr, Dolj county, 44°08'48.31"N, 23°43'55.19"E, 152 m a.s.l. (leg. I. Șt. Iorgu); 3 ♂♂, 2 ♀♀, 25.06.2010, Comana forest, near Comana (leg. I. Șt. Iorgu) (Fig. 1); 6 ♂♂, 3 ♀♀, 09.05.2011, Greci, Tulcea county, 45°13'13.66"N, 28°14'25.76"E, 145 m a.s.l. (leg. I. Șt. Iorgu); 11 ♂♂, 7 ♀♀, 26.05.2011, Bârnova forest, near Dobrovăț, Iași county, 46°59'23.05"N, 27°40'12.96"E, 227 m a.s.l. (leg. I. Șt. Iorgu & E. I. Iorgu); 4 ♂♂, 4 ♀♀, 07.06.2011, Niculițel, Tulcea county, 45°09'45.66"N, 28°28'52.54"E, 330 m a.s.l. (leg. I. Șt. Iorgu); 1 ♂, 26.05.2012, Miclăușeni, Iași county, 47°05'38.54"N, 26°55'26.89"E (leg. I. Șt. Iorgu) (Fig. 2).

This is the first record of the species West of Olt River, Cobia forest representing the new South-Western border of its distribution area.

*Audio recorded material.* 1 ♂, 04.06.2007, Bârnova forest, near Poiana cu Cetate (air temperature 20°C); 2 ♂♂, 19.05.2010, Comana forest, near Comana (air temperature 18°C); 2 ♂♂, 27.05.2010, Cobia forest, near Calopăr; (air temperature 23°C); 2 ♂♂, 25.06.2010, Comana forest, near Comana (air temperature 25°C); 6 ♂♂, 26.05.2011, Bârnova forest, near Dobrovăț (air temperature 21°C); 3 ♂♂, 07.06.2011, Niculițel (air temperature 24°C).

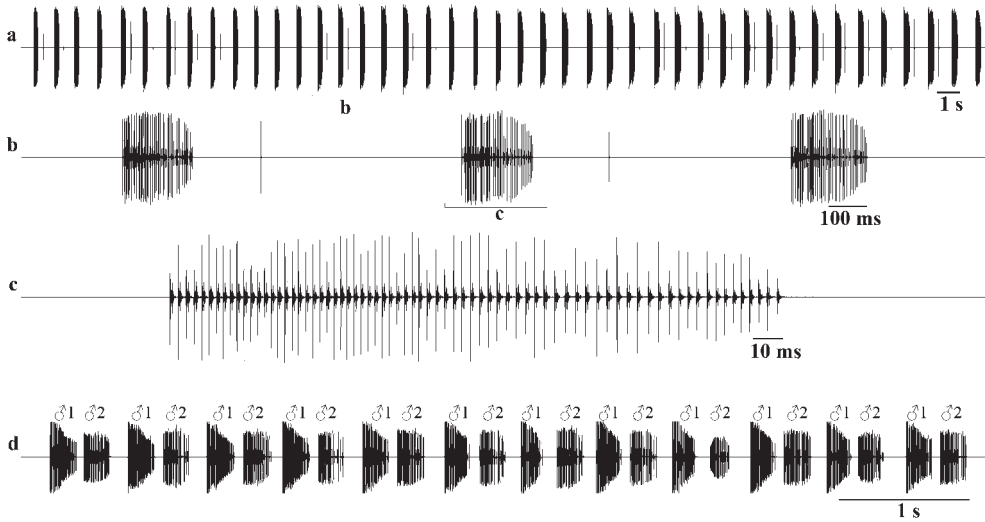


Fig. 3 - Oscillographic analysis of sound in *Isophya zubowskii*: a, calling song; b, c, detailed syllables; d, rivalry song of two males (temperature 21°C).

**Bioacoustics.** As most of the other *Isophya* species, this bush-cricket also sings only at dusk and during the night. Male's calling song consists of a temporal variable series of syllables, lasting from a few seconds to more than 4 minutes, repeated at a rate of about 62-81 / minute (Fig. 3). All sounds are produced when the insect closes the tegminae. The syllables are composed of 74-118 impulses (mean  $\pm$  SD:  $94.2 \pm 10.1$ ) and last for 182-319 ms (mean  $\pm$  SD:  $225.7 \pm 33.4$ ) (Tab. 1). Towards the end of each syllable, impulses gradually descend in amplitude; the break between two successive syllables is about 432-1127 ms. Often, an after-click follows the syllable after a period of 110-180 ms.

The longest syllables were recorded in individuals from the surroundings of Iași (236-319 ms), while the individuals from the southern part of species distribution area produce shorter syllables (182-251 ms). The number of pegs on the stridulatory file also differs in the analyzed populations: 227 pegs were observed in a male from Dobrovăț, 181 in a male from Comana, 212 at Cobia and 203 pegs in a male collected at Niculițel (Fig. 4). These differences in stridulatory files explain the dissimilarities

Table 1  
Song characteristics of *Isophya zubowskii* in Romania (n = number of recorded males).

Male song	Location	n	Maximum	Minimum	Mean	SD
number of impulses in a syllable (♂)	Dobrovăț	4	118	85	101.5	10.3
	Comana	4	88	74	80.9	5.7
	Cobia	2	105	97	99.7	2.2
	Niculițel	3	100	92	94.9	3.2
syllable duration (♂) (ms)	Dobrovăț	4	319	236	269.8	28.6
	Comana	4	251	182	216.1	27.5
	Cobia	2	234	191	207.3	13
	Niculițel	3	231	188	209.9	13.5

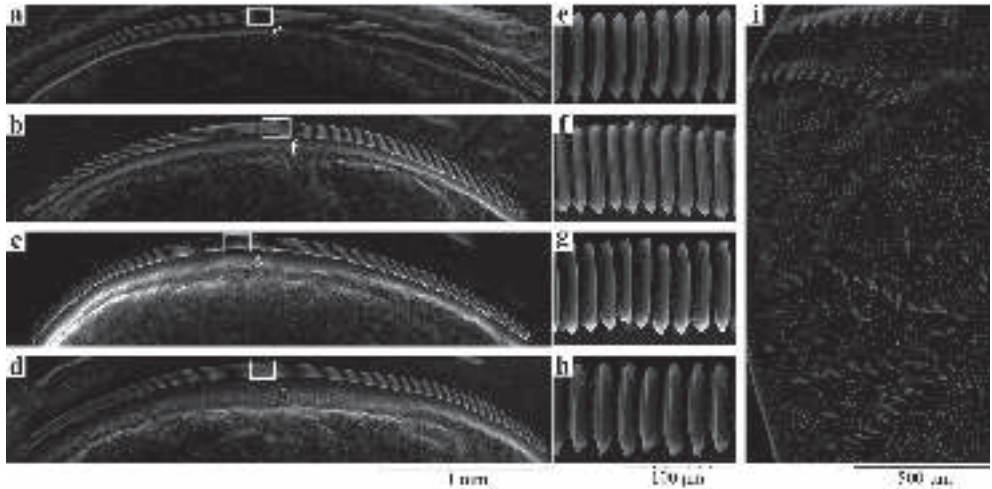


Fig. 4 - Stridulatory file in *Isophya zubowskii* from: a, e, Dobrovăț; b, f, Comana; c, g, Cobia; d, h, i, Niculițel (a-h, males; i, female; e, f, g, h, detailed areas of male stridulatory file) (SEM photos).

in syllable length and impulse number in individuals from distinct populations. Females also have stridulatory bristles on the wings (Fig. 4 i), but in our experiments they did not sing as male acceptance for mating and only approached silently when willing to mate with the singing male.

Male rivalry song was noticed occasionally. Males try not to stay close to each other for too long and usually one of them leaves the area. In such situation, males produce the regular song, sometimes overlapping the syllables in the duet. Syllable length, number of impulses and period between successive syllables are not affected (Fig. 3 d).

The song frequency in the four studied populations varies without significance, the main impulse series' frequency ranging between 10-40 kHz. However, the highest peak is variable: about 21 kHz at Dobrovăț, 26 kHz at Comana, 18 kHz at Cobia and about 22 kHz at Niculițel (Fig. 5).

In 2008, Warchałowska-Słiwa et al. stated that *Isophya zubowskii* might belong to the one of the closely related species groups *I. costata* or *I. kraussii*. The *I. costata* group contains moderately large to large species with long pronotal disc; widened in metazona, distinctly widened and short tegminae, cerci variable in shape and moderately short to long ovipositor (Warchałowska-Słiwa et al., 2008). In *I. costata*, the stridulatory file bears 250-280 pegs and the song consists of isolated syllables, each composed of 102-130 impulses followed by a series of 1-17 after-clicks (Heller et al., 2004). Males of *I. stysi* have 54-133 pegs on the stridulatory file and produce syllables of 20-60 impulses, lasting for 110-270 ms, while in *I. modestior*, the stridulatory file has 117-167 pegs and the syllables last for 127-260 ms, being formed by a number of 35-80 impulses (Orci et al., 2005; I. Șt. Iorgu, unpublished). Syllables in *I. stysi* begin with a few temporally distinct impulses. Isolated after-clicks were recorded in both *I. stysi* and *I. modestior*.

*Isophya kraussii* group contains moderate sized species with long pronotal disc, widened in metazona, distinctly shortened tegminae, moderately stout to moderately slender cerci, with gradually curved apex and moderately short ovipositor (Warchałowska-Słiwa et al., 2008). In this group, the syllables of *I. pienensis* are

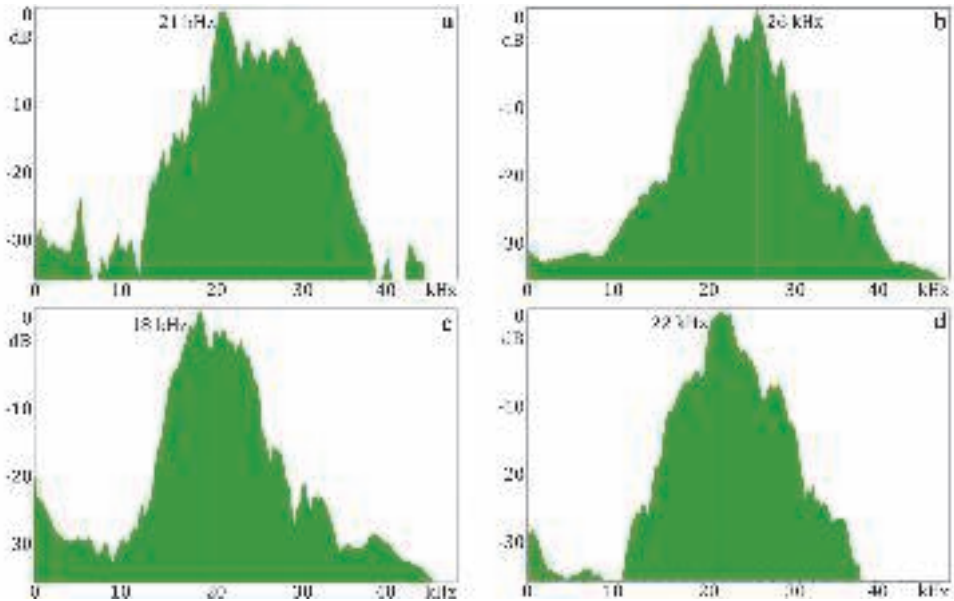


Fig. 5 - Spectral analysis of sound in *Isophya zubowskii* males from: a, Dobrovăț; b, Comana; c, Cobia; d, Niculițel.

long, consisting of 76-105 impulses and lasting for 300-510 ms, while *I. kraussii* produces shorter syllables: 80-125 impulses, lasting for 250-364 ms (Heller et al., 2004). The stridulatory file has a very high number of teeth in the species from this group: 180-225 in *Isophya pienensis* and 260-305 in *I. kraussii* (Heller et al., 2004; Iorgu, 2011).

Based on the structure of the calling song and on morphological traits, especially the structure of cerci and tegminae, *Isophya zubowskii* is better placed in *I. kraussii* group.

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#### DESCRIEREA STRIDULAȚIEI LA COSAȘUL LUI ZUBOVSKI, *ISOPHYA ZUBOWSKII* (ORTHOPTERA: PHANEROPTERIDAE)

#### REZUMAT

Cosașul *Isophya zubowskii* Bey-Bienko, 1954 a fost cercetat în perioada 2002-2012 din 11 situri situate în România. Stridulația cosașului *I. zubowskii*, descrisă pentru prima dată în această lucrare, constă într-o serie lungă de silabe, formate din 85-118 impulsuri și care durează 236-319 ms în populațiile din împrejurimile orașului Iași, în timp ce indivizii din alte 3 populații din sudul României au silabe relativ mai scurte, compuse din 74-105 impulsuri și durând 182-251 ms. Frecvența sunetului se încadrează între 10-40 kHz, cu maximum între 18-26 kHz. În urma descrierii stridulației la această specie, putem afirma că *I. zubowskii* aparține grupului *Isophya kraussii*.

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