

## Song of *Cicadetta flaveola* Brullé (Auchenorrhyncha: Cicadoidea: Tibicinidae) from Greece

## Песня *Cicadetta flaveola* Brullé (Auchenorrhyncha: Cicadoidea: Tibicinidae) из Греции

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KEY WORDS: *Cicadetta flaveola*, song, bioacoustics, singing cicadas.

КЛЮЧЕВЫЕ СЛОВА: *Cicadetta flaveola*, песня, биоакустика, певчие цикады.

**ABSTRACT.** Brullé described in his book [1832] *Cicadetta flaveola* from Peloponnesus (Mistras, Sparta) and later it has been reported from various Mediterranean countries. Nevertheless, the song of this species has not been described until now. We found this species on Peloponnesus (Greece) in four different localities and recorded its song. It is characterized by three different patterns or phrases, a basic one comprising equally long echemes (A) and two other phrases (B and C), composed of characteristic sequences of short and long echemes, with durations of a few seconds, which follow each other without interruptions for a few minutes. A basic acoustic unit is a group of 4 tymbal clicks with a duration of 7–9 ms and all other echemes are composed of different numbers of such 4-click units.

**РЕЗЮМЕ.** В своей книге Брюлле [Brullé, 1832] описал *Cicadetta flaveola* с Пелопоннеса (Мистрас, Спарта). Позже этот вид был указан из различных средиземноморских стран. Однако, его песня до сих пор не была описана. Мы обнаружили этот вид на Пелопоннесе (Греция) в четырёх различных местах и записали его песню. Она характеризуется тремя различными типами фраз. Основной тип представлен одинаково длинными сериями (А) и двумя другими фразами (В и С), состоящими из характерного чередования коротких и длинных серий с продолжительностью в несколько секунд и, следующими друг за другом без перерывов в течение нескольких минут. Основная акустическая единица представляет собой группу из 4 тимбальных щелчков продолжительностью 7–9 мс и все другие серии состоят из различного числа подобных 4-щелчковых единиц.

### Introduction

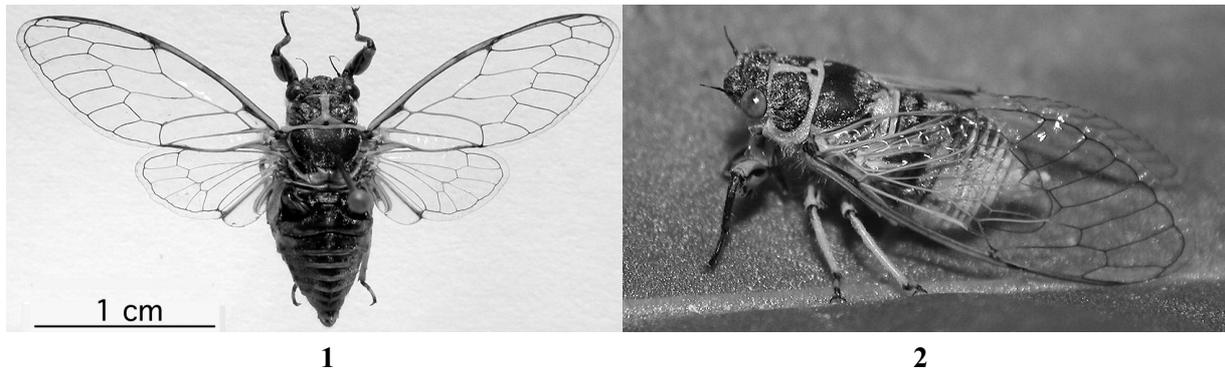
In the recent years it has been shown, that singing cicadas of Europe are not known to such extent as supposed previously. Bioacoustic investigations, combined with morphological and molecular approaches shed new light on the taxonomy of this group of insects. By acoustic methods it is much easier to single out singing animals in vegetation and recognize their identity. This is true also for the fauna of Cicadoidea of Greece. Our aim was to search especially for the small singing cicadas in Greece, which were previously not studied in detail. In this paper we are describing the song characteristics of *Cicadetta flaveola* (Brullé, 1832) described from Peloponnesus (Mistras near Sparti). The song of this species has not been previously investigated [Sueur, 2001; Puissant & Boulard, personal communication].

### Materials and Methods

In the years 2004 and 2005 both authors made field trips to the eastern part of Peloponnesus in the time periods of May 19–26, 2004 and June 9–12, 2005.

Material collected during our field trips: (2) Fteri, Peloponnesus, (~1200 m elev.), 9.VI.2005, (2) Kastanitsa, Peloponnesus (~1000 m) 9.VI.2005.

For acoustic detection and recording of songs we used following equipment: the ultrasonic detector PETERSSON D-200 with a detached microphone, mounted in front of a TELINGA reflector and a solid state recorder MARANTZ PMD-670 with compact flash card 1 and 2 GB. In the year 2004 also a SONY DAT recorder



Figs 1–2. *Cicadetta flaveola* Brullé: 1 — prepared specimen from the locality near Fteri, Peloponnesus; 2 — live animal from the same locality.

Рис. 1–2. *Cicadetta flaveola* Brullé: 1 — наколотый экземпляр из окрестностей Фтери, Пелопоннес; 2 — живой экземпляр из той же местности.

TCD-D10 was used. For analyses of sound we used RAVEN 1.2, CANARY 1.4 and AMADAEUS software and for statistical evaluation MICROSOFT EXCELL on an APPLE iMac G4 computer.

Cicadas were first localized acoustically and then collected with entomological net. The dry prepared animals are in the collection of the Slovenian Museum of Natural History in Ljubljana (PMSL) and in the collection of S. Drosopoulos. All sound recordings are stored in the Sound Archive of the Slovenian Museum of Natural History in Ljubljana. The samples of the song are available on the web page: <http://www2.pms-lj.si/european-cicadas/>.

## Results

In various collections we found specimens of *C. flaveola* from Peloponnesus and some other localities in Greece, often with wrong determination labels. Comparing the morphology of the specimens with the original description it became clear that these specimens belong to the taxon mentioned above and described by Brullé from Mistra(s) near Sparti.

During our field trip in 2004 we recorded in the locality Ag. Andreas a characteristic cicada song, recognized by one of us (S.D.) as a specific one for *C. flaveola*. One year later (2005) we visited Peloponnesus and near the village Fteri (~ 1200 m above sea level) on June the 9th acoustically detected and recorded and later also collected some cicadas of this species (Figs 1, 2). It turned out that the song differs from all previously known song patterns of European singing cicadas. The next locality, where the species has been found, recorded and collected was above the village of Kastanitsa on the slopes of the Parnon Mountain (~ 1000 m a.s.l.). During the following day we recorded the species also near the village of Kastri (800 m). After a comparison of songs it became very likely that also our recordings from the previous year in Ag. Andreas were produced by males of the same species. However, those males were singing in small trees or shrubs and not in grasses.

## Description of the song pattern

**TIME PARAMETERS.** The calling song of this species consists of repetition of short echemes (S) of similar duration (phrase A) as a basic pattern and of two different parts (phrases B and C) with more or less regular sequences of longer (L) and shorter echemes (S) (Fig. 3). In the phrase B the echemes follow the pattern: L S S L S S L... (Fig. 3a) and in the phrase C the pattern is simpler L S L S L... (Fig. 3b). Sometimes this pattern is also changing during a phrase (last phrase B–C in Fig. 3b). Singing animals switch without interruption between these rhythmic patterns or phrases. They may interrupt singing in any phase of their song, but usually during the basic repetition of the echemes of equal length i.e. phrase A. The duration of phrases B is typically 2–3 s and between these phrases there are 3 to 5 s long sequences of short echemes (phrase A) (Figs 3a, 5). The phrases C are usually longer, 3–5 s, separated by “A” phrases of approximately 1 s duration (Figs 3b, 7).

In the Figs 5 and 7 one can see that the short echemes can last for about  $8 \pm 1$  ms, 16–18 ms or 25–29 ms and there is a reason for this. The shortest echemes in all three phrases comprise a basic pattern of 4 tymbal clicks (Fig. 4a). Such shortest echemes occur most often in the phrase B and sometimes in A and C. Looking at this pattern in more detail one can actually recognize 4 double clicks: the inward movement of a tymbal producing a very soft click and the outward movement a loud one (Fig. 4a). From the pictures 4, 5 and 7 it is evident that short echemes in the basic phrase A are often composed from 3 and sometimes 2 of such basic 4-click units. Also the long echemes, typical for phrase B and C usually contain 8 (6–9) 4-click units (Figs 4b, 5, 7). Therefore, the duration of echemes is distributed stepwise as shown clearly in Figs 5 and 7.

The intervals between echemes and the repetition rate of echemes differ slightly from case to case, being in phrases A and C between 70 and 110 ms and change also within phrases, as shown in Fig. 6 during phrase B. The repetition rate of echemes in a phrase A is typically 7–11 echemes per second.

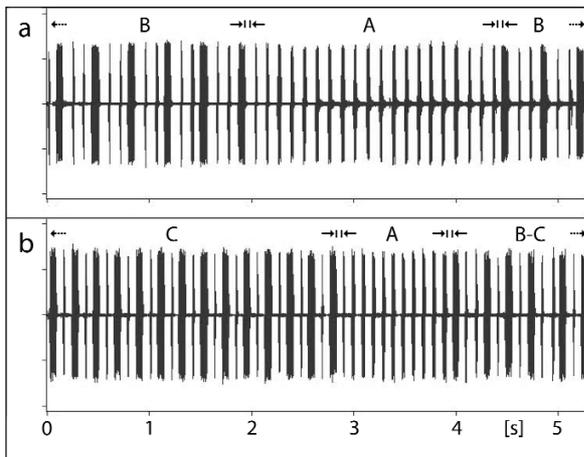


Fig. 3. Oscillograms of the calling song of *Cicadetta flaveola* Brullé: a — phrases B, A, B; b — phrases C, A and mixed phrase B-C.

Рис. 3. Осциллограммы призывного сигнала *Cicadetta flaveola* Brullé: а — фразы В, А, В; б — фразы С, А и смешанные фразы В-С.

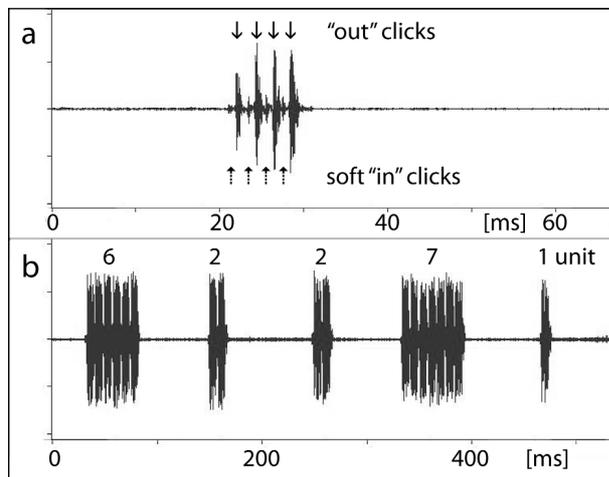


Fig. 4. Oscillograms showing pulse structures of *Cicadetta flaveola* Brullé: a — sample of the shortest echeme with 4 double pulses, soft “in” and loud “out” clicks representing the basic “4-click unit”; b — 2 long echemes comprising 6 and 7 “4-click units” and 3 short echemes comprising 2 and 1 unit. Note a different time scale in Fig. 4b!

Рис. 4. Осциллограммы показывают пульсирующие структуры *Cicadetta flaveola* Brullé: а — пример самой короткой серии с 4 двойными пульсами, тихие щелчки “прогибания тимбала” и громкие “выгибания тимбала” представляют собой основную “4-щелчковую единицу”; б — 2 длинные серии, состоящие из 6 и 7 “4-щелчковых единиц” и 3 короткие серии, состоящие из 2 и 1 единиц. Обратите внимание, что на Рис. 4б другая временная шкала!

**FREQUENCY RANGE.** The frequency spectrum of the *Cicadetta flaveola* calling song has a wide range. There is a main peak of frequencies between 13.5 and 16 kHz with a secondary peak or plateau in the range of 6 to 8 kHz. The -20 dB range of the main peak covers the frequencies between 8 and 19 kHz. Such frequency characteristics can be expected from the size of these singing cicadas [Bennet-Clark & Young, 1994].

Due to the high frequency content of this song it makes sense to use the ultrasonic or “bat” detector for listening, detecting and recording these cicadas in the field.

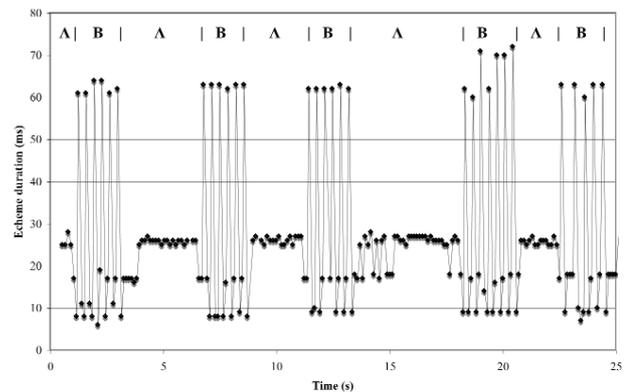


Fig. 5. Graph showing echeme durations during phrase A and B of the song of *Cicadetta flaveola* Brullé. Duration of shortest echemes is about 8 to 9 ms, higher values of short echeme durations are two to three times higher than the “4-click unit”. Long echemes in phrases B are in this recording composed by 7–8 basic units.

Рис. 5. График, показывающий продолжительность серий в течение фраз А и В песни *Cicadetta flaveola* Brullé. Продолжительность самых коротких серий — приблизительно от 8 до 9 мс, более высокие значения продолжительностей коротких серий в 2–3 раза выше чем “4-щелчковая единица”. Длинные серии во фразах В этой записи состоят из 7–8 основных единиц.

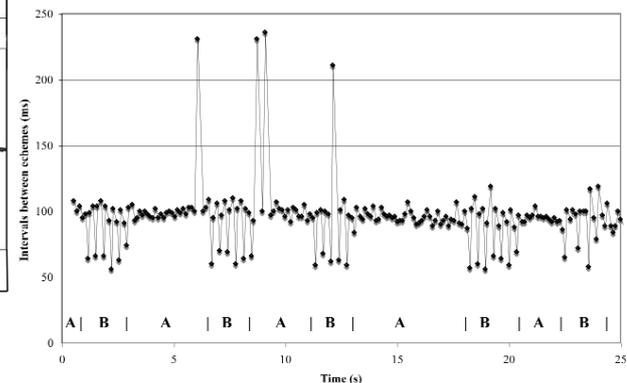


Fig. 6. Graph showing intervals between echemes during the same song sequence of *Cicadetta flaveola* Brullé as in Fig. 5. During B-phrases every third interval substantially shorter compared with others in both phrases.

Рис. 6. График, показывающий интервалы между сериями в том же фрагменте сигнала *Cicadetta flaveola* Brullé, как на Рис. 5. В течение фразы В каждый третий интервал существенно короче по сравнению с другими в обоих фразах.

**ECOLOGY.** As mentioned before we found this species in localities between 100 and 1200 m. They usually sit and sing on grass or other green plants in meadows or forest clearings. They are active at daytime and call at temperatures between 16 and 25°C or higher. The single male is singing periodically at the same spot for one or a few minutes, then, when it stops, another male starts to sing a few meters away, then the next one or again the first one. Therefore and due to the cryptic green to yellow coloration it is not easy to spot the singing males in the field.

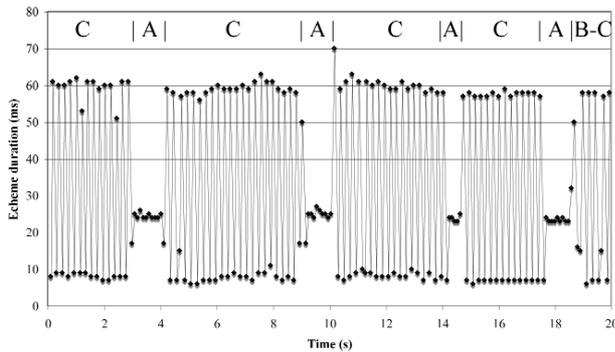


Fig. 7. Graph showing echeme durations during phrase A and C of the song of *Cicadetta flaveola* Brullé. The last phrase in the graph is a mixed one with elements of B and C. One can see the regular sequence of one long and one short echeme during the C phrase. Phrases C are separated by phrases A with short echemes composed by 3 basic "4-click units".

Рис. 7. График показывает продолжительность серии в течение фраз А и С песни *Cicadetta flaveola* Brullé. Последняя фраза на графике представляет собой смесь элементов фраз В и С. Можно видеть регулярную последовательность одной длинной и одной короткой серий в течение фразы С. Фразы С разделены фразами А с короткими сериями, состоящими из 3 основных "4-щелчковых единиц".

## Discussion

First we have to mention that according to Boulard and Puissant (pers. comm.) the taxon *Cicadetta flaveola* should be placed, by some morphological characters especially the wing venation (5 apical cells in the hind wings and a common root of M and CuA vein in front wings), into the genus *Cicadivetta* [Boulard, 1982]. Since this opinion is not published yet we did not change the name of the genus.

A song pattern closest to the one of *Cicadetta flaveola* described above is probably the song of *Euryphara contentei* Boulard, 1982 [Quartau & Simões, 2004]. The ecology and behaviour of the *E. contentei* is similar to the eco-ethology of the *C. flaveola* since both are singing on grass or herbaceous plants [compare Sueur et al., 2004]. Another species with similar ecology from Europe is *Cicadetta mediterranea* Fieber 1876. Also in this species one phrase (phrase II) consists of very short echemes (11–17 ms) with high repetition rate and long echemes [Gogala & Popov, 1997]. This could be an adaptation to the acoustic conditions in such habitats but such a hypothesis should be supported by exact acoustic measurements.

Terra typica of *C. flaveola* is, as mentioned before, Peloponnesus, Greece. Nevertheless, the geographic

distribution of this species reported by some authors is much wider. Nast [1972] and Duffels & van der Laan [1985] mention in addition to Greece the following countries: Algeria, Italy (Sicily), Morocco, Portugal, Spain, Georgia, Kazakhstan, Tadzhikistan and Turkmenia. Nevertheless, Sueur et al. [2004] could not find this species during recent field work in Portugal.

Even for Greece there are data not only for Peloponnesus but also for East Macedonia and the island of Kalymnos (Dodekanesos) [Drosopoulos, unpublished data]. Now, with the knowledge of its calling song, the distribution of *C. flaveola* will be much easier to check.

**ACKNOWLEDGEMENTS.** We are thankful to Dr. Andrej Gogala, who did the preparations of collected specimens for the PMSL collection. We are also grateful to Stéphane Puissant (Perpignan), Michel Boulard (Paris) and J. P. Duffels (Amsterdam) for advice in determination and additional literature. This research has been financially supported by the Slovenian Academy of Sciences and Arts, Ljubljana.

This paper is dedicated to the renowned Russian hemipterologists Prof. Alexander F. Emelyanov and Prof. Izyaslav M. Kerzhner.

## References

- Bennet-Clark H.C. & Young D. 1994. The scaling of song frequency in cicadas // *Journal of Experimental Biology*. Vol.191. P.291-294.
- Boulard M. 1982. Taxa nouveaux pour la faune des Cigales de France (Hom.) // *Bull. Soc. ent. France*. T.87. No.1-2. P.49-50.
- Brullé M.A. 1832. Expedition scientifique de Moree. Section des Sciences physiques. T.3. Pt.1. Zoologie, Paris.
- Duffels J.P. & van der Laan P.A. 1985. Catalogue of Cicadoidea (Homoptera, Auchenorrhyncha) 1956-1980. Dr. W. Junk Publishers, Dordrecht, Boston, Lancaster.
- Gogala M. & Popov A.V. 1997. Bioacoustics of singing cicadas of the Western Palaearctic: *Cicadetta mediterranea* Fieber 1876 (Cicadoidea: Tibicinidae) // *Acta entomologica slovenica*. Vol.5. No.1. P.11-24.
- Nast J. 1972. Palaearctic Auchenorrhyncha (Homoptera). An annotated checklist. Warszawa: Polish scientific publishers.
- Quartau J.A. & Simoes P.C. 2004. First description of the calling song produced by *Euryphara contentei* Boulard, 1982 (Insecta, Hemiptera, Cicadoidea) in Portugal // *Arquivos do Museu Bocage, Nova Serie*. Vol.3. No.22. P.563-572.
- Sueur J. 2001. Audiospectrographical analysis of cicada sound production: a catalogue (Hemiptera: Cicadidae) // *Deutsche Entomologische Zeitschrift*. T.48. Ht.1. S.33-51.
- 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) // *Insects Systematics and Evolution*. Vol.35. No.2. P.177-187.