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Bioacoustics of *Metrioptera caprai baccettii* Galvagni 1958 (Orthoptera: Tettigoniidae: Tettigoniinae)

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Abstract

The song of *Metrioptera caprai baccettii* Galvagni 1958, an endemic subspecies of the Monti Sibillini region of Central Italy, is here described. The calling song consists of long series of polysyllabic echemes and differs from conspecific subsp. in having the lowest echeme repetition rate. The main differences between the subspecies lie in morphological characters: male subgenital plate, female ovipositor, lowest number of stridulatory pegs.

Key words

acoustic signals, stridulatory apparatus, endemism, Monti Sibillini, conservation

Introduction

Metrioptera caprai Baccetti 1956, is endemic to the Italian Apennines and comprises four subspecies (Fontana *et al.* 2005): *M. c. caprai* Baccetti 1956, from Monti Reatini, Monte Prato and Monte Velino; *M. c. baccettii* Galvagni 1958, from Monti Sibillini; *M. c. galvagnii* Baccetti 1963, from the Ligurian and Tuscanian Apennines; *M. c. lagrecai* Baccetti 1958 from Gran Sasso d'Italia. The subspecies are distinguished on the basis of the female subgenital plate, ovipositor and by male titillator spinulation (Baccetti 1956, 1958, 1963).

The song of the species was first described by Pfau (1986), followed by the publication of oscillograms by Ragge (1987). Heller (1988) compared the songs of several *Metrioptera* species and found that of *M. caprai* very similar to the songs of *M. saussuriana* from the Alps, Vosges and Pyrenees, of *M. buyssoni* (Saulcy, 1887) from the French Pyrenees and of *M. ambigua* Pfau, 1986, from north Spain: all are made of short echemes (verses), with occasionally added microsyllables.

Ragge & Reynolds (1998) discuss the bioacoustics of *M. caprai*, illustrating two different songs, one of a male from Monte Terminillo on Monti Reatini, the other from Gran Sasso. Though these authors are doubtful of the status of *M. caprai* and even about the identity of its recognized subspecies, the songs that they illustrate are assignable — based on the locality — to *M. c. caprai* and to *M. c. lagrecai* respectively.

Metrioptera c. baccettii is endemic to the Monti Sibillini region of central Italy. It is described by Galvagni (1958) on the basis of specimens collected August 2 1955 on Monti Sibillini in the Valley of Bolognola; the exact locality is Fonte Bassete on the northern slope of Monte Castel Manardo, Pizzo Tre Vescovi (Fig. 1C), at an altitude of 1500 to 1600 m.

During a recent expedition carried out on Monti Sibillini in the Summer of 2004, two new populations of this interesting subspecies were discovered on the eastern slope of Monte Rotondo and on Forcella Angagnola (Fig. 1C).

Material and methods

Specimens were collected and transported to north Italy alive in plastic cages. The males (specimens designated A, B, C) were recorded a few days later. The recording cage was a 20-cm cube, framed of wire, with netting on all its faces, lying on polystyrene foam. Three males were recorded in the following situations: male A at 24 °C, with three females in the same cage (Fig. 7), male B at 25 °C with one female in the cage (Fig. 6) and male C alone at 26 °C (Fig. 4). All these singers were probably quite mature because no nymphs were observed in the population from which they came.

A digital recorder was used, Sony DAT TCD-D100, with a clamped condenser microphone. This system has a frequency response of 100 to 15000 Hz. The microphone was placed approximately 25 cm from the cage, perpendicular to the plane of one of its sides. The microphone was mostly perpendicular to the insect's body during its song. Sampled fragments of more than 1 min. (44.1 kHz, 16 bit) from the recordings were analysed with Cool Edit Pro 2.0 to obtain oscillograms. Recording temperatures were 24 to 26 °C. The song files are deposited in SysTax databank (SysTax, 2006).

Song terminology follows Ragge & Reynolds (1998): *calling song* — the song produced by an isolated male; *syllable* — the sound produced by one complete opening and closing movement of the tegmina; *hemisyllable* — the sound produced by one unidirectional movement, opening or closing, of the tegmina; *echeme* — a first-order assemblage of syllables.

The song of *M. c. baccettii* is here compared with the song of one topotypical male of *M. c. caprai* from M. Terminillo, recorded by K.-G. Heller, 2.IX.1996, Italy, Lazio, Rieti, Mt. Terminillo, lat 42 °28'N, long 13 °0'E, 1800 m, lab recording, recording temperature 17.5 to 23 °C (SysTax, 2006).

Results

Metrioptera caprai baccettii Galvagni 1958

Metrioptera Caprai Baccettii Galvagni, 1958.
Metrioptera Caprai Baccettii: Galvagni, 1959: 23.
Metrioptera caprai baccettii: Harz, 1969: 293. *Metrioptera caprai baccettii*: Failla *et al.*, 1994: 8.
Metrioptera caprai baccettii: Otte, 1997: 277.
Metrioptera caprai baccettii: Naskrecki & Otte, 1999: CD ROM.

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Fig. 1. *Metrioptera caprai baccettii* Galvagni, 1958. **A**. Female from Monte Rotondo; **B**. Male from same locality (Photo G. C.); **C**. Habitat of *Metrioptera c. baccettii* at locality Monte Rotondo: on the left is the new locality on the slope of M. Rotondo, in the right background is the locality Fonte Bassete (Photo F. M. B.).

Metrioptera caprai baccettii: Fontana *et al.*, 2005: CD ROM.
Examined material.—Italy, Marche region, Monti Sibillini, Monte Rotondo, lat 42°57′56″N, long 013°11′43.4′E′, 2101 m, 29.VIII.04, 3♂♂ 5♀♀, *leg.* F. M. B. & G. C.; eastern slope of Forcella Angagnola, 1890 m, 29.VIII.04, 1♀, *leg.* L. Esposito, M. Gottardo & P. Tirello.

All recorded material is from M. Rotondo.

The calling song of *Metrioptera caprai baccettii* (Figs 4, 6, 7) is a long series of polysyllabic echemes, repeated at an average rate for the three-male sample of 1.9/sec (range 1.7 to 2.0). Each echeme was comprised of a variable number of syllables, from 9 up to 15, of increasing volume. This song usually lasted 1 to 2 min, but could be preceded and followed by a shorter echeme series or by time-isolated echemes as shown in Fig. 6A; or alternatively even the regular rate could be briefly interrupted (Fig. 7A).

In the three recorded males the average number of echemes emitted in 10 s was greater at higher temperatures, since C emitted 20 echemes (26°C), B emitted 18 echemes (25°C) and A emitted 17 echemes (24°C). The number of syllables per echeme varied between 9.5 (male A and B) and 14.2 (male C). These differences might be correlated with the presence of females, since male C was singing alone, while males A and B were singing with females nearby. However such differences could also arise from individual variability because the syllable number per echeme given for each male is the average of 10 echemes.

The presence of light or darkness seemed to have no effects on song because the higher and lower echeme repetition rates were both emitted in the dark (males A and C). The different number of echemes emitted is best attributed to temperature differences, this being the factor that mainly affects echeme repetition rate (Ragge & Reynolds, 1998).

Every echeme (Fig. 4BC, 6B, 7BC) lasts for 0.25 to 0.40 s and is separated from the following one by an interval of 0.4 to 0.6 s. In some cases an echeme can be followed by four to six microsyllables as shown in Figs 4C and 7C. This is similar to that observed by Ragge & Reynolds (1998) for *Metrioptera caprai* Baccetti 1956 in Gran Sasso and Monte Terminillo. The microsyllables are different from normal syllables in having the closing hemisyllables shorter than the normal, so that the total length of each microsyllable is not more than 3 msec. The average frequency of such "prolonged echemes" (Ragge and Reynolds, 1998) in the song was different in the recorded males, 5.7 (range 4 to 8) simple echemes between two prolonged echemes in C, 18 in B and about 14 in A. As pointed out by Samways (1976), microsyllables could be a signal directed to other males and their occurrence and frequency reduced if females are nearby (males A\and B).

Each prolonged echeme lasts about 500 msec. In the echeme the syllables are separated by intervals of 3 to 4 msec. The male stridulatory file (Fig. 3A) contains 58 pegs in 1.75 mm (33.14 per mm) and is slightly curved. *Metrioptera caprai baccettii* have been heard singing in the field during the day even under a light rain, while in the laboratory they can sing at every hour of the day in both light and dark.

Discussion

Comparing the songs of *M. caprai* subspecies, differences are recognisable between that of *M. c. baccettii* and those of *M. c. caprai* and *M. c. lagrecai*. The number of syllables per echeme is 12 in topotypical *M. c. caprai* (Ragge & Reynolds 1998, Systax 2006), eight in *M. c. lagrecai* (Ragge & Reynolds, 1998) and 9 to 15 in *M. c. baccettii*. Syllable repetition rate is 32.5 per s in *M. c. caprai* (23°C), 37.5 per s (range 35 to 40) in *M. c. baccettii* (24 to 26°C), 60 per s in *M. c. lagrecai* (18°C). Echeme repetition rate is lowest in *M. c. baccettii* being 1.7 to 2 per s; it is higher in *M. c. caprai* and *M. c. lagrecai,* with 4.2 and 3 per s respectively. The number of pegs comprising the stridulatory file is highest in the genus in *M. c. lagrecai* with 89

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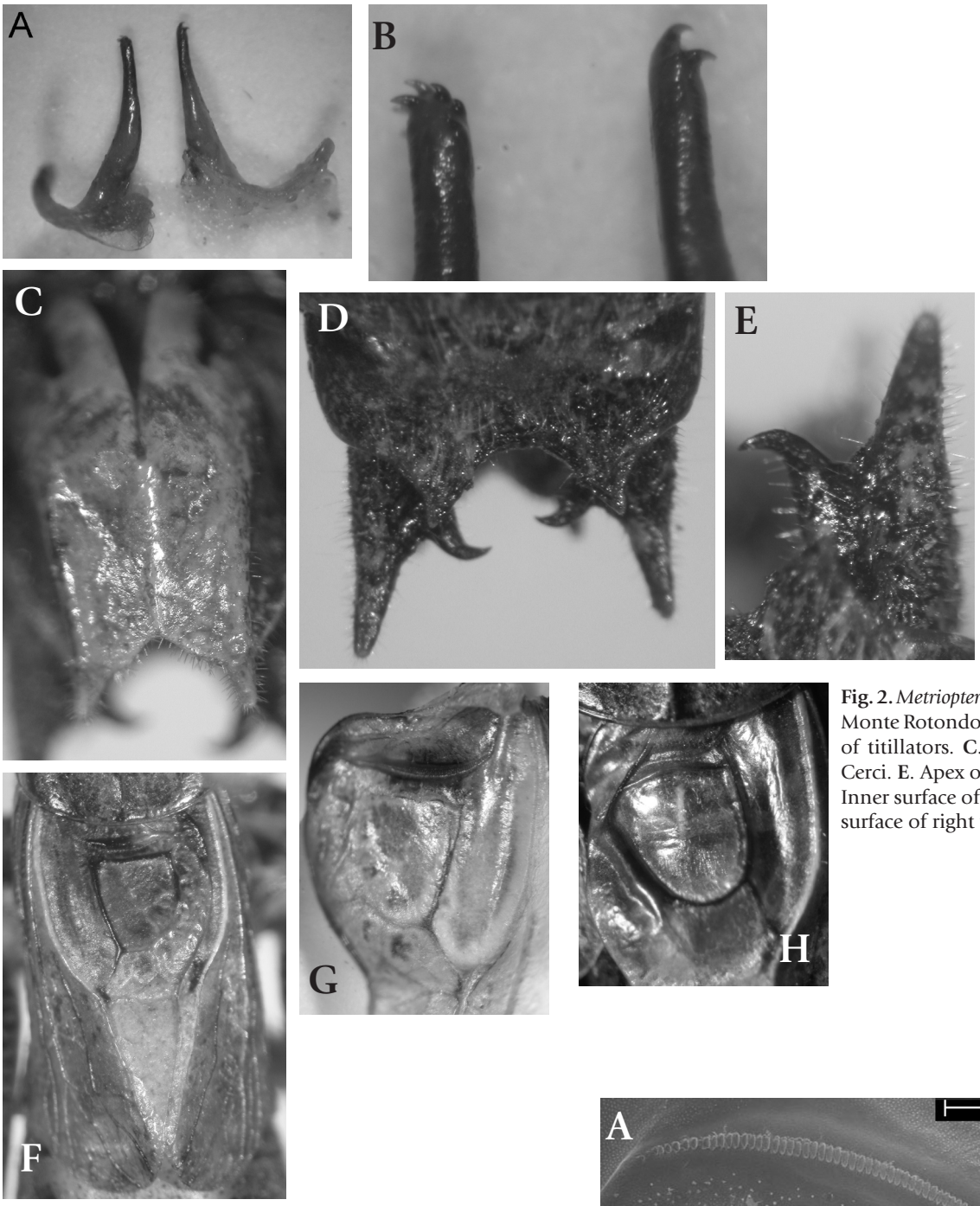


Fig. 2. *Metrioptera c. baccettii*, Male from Monte Rotondo. **A**. Titillators. **B**. Apex of titillators. **C**. Subgenital plate. **D**. Cerci. **E**. Apex of cerci. **F**. Tegmina. **G**. Inner surface of left tegmen. **H**. Outer surface of right tegmen.

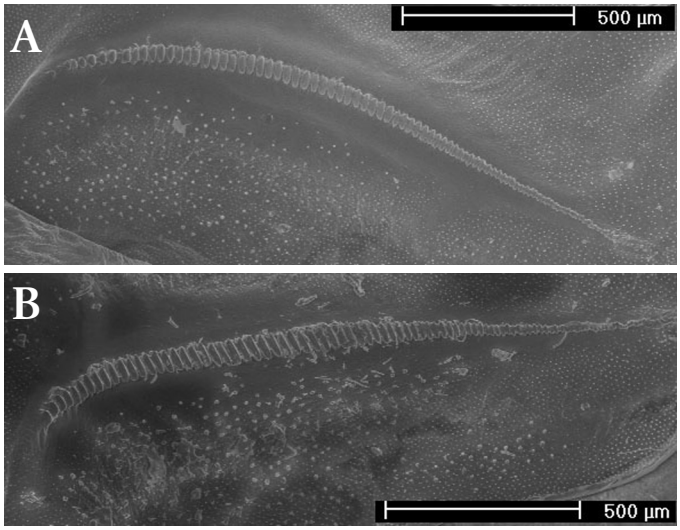


Fig. 3. A. Stridulatory file of *M. c. baccettii* from Monte Rotondo. **B**: Stridulatory file of *M. c. caprai* from Monte Terminilletto, 1800-2000 m., 14.IX.96, *leg.* P. Fontana.

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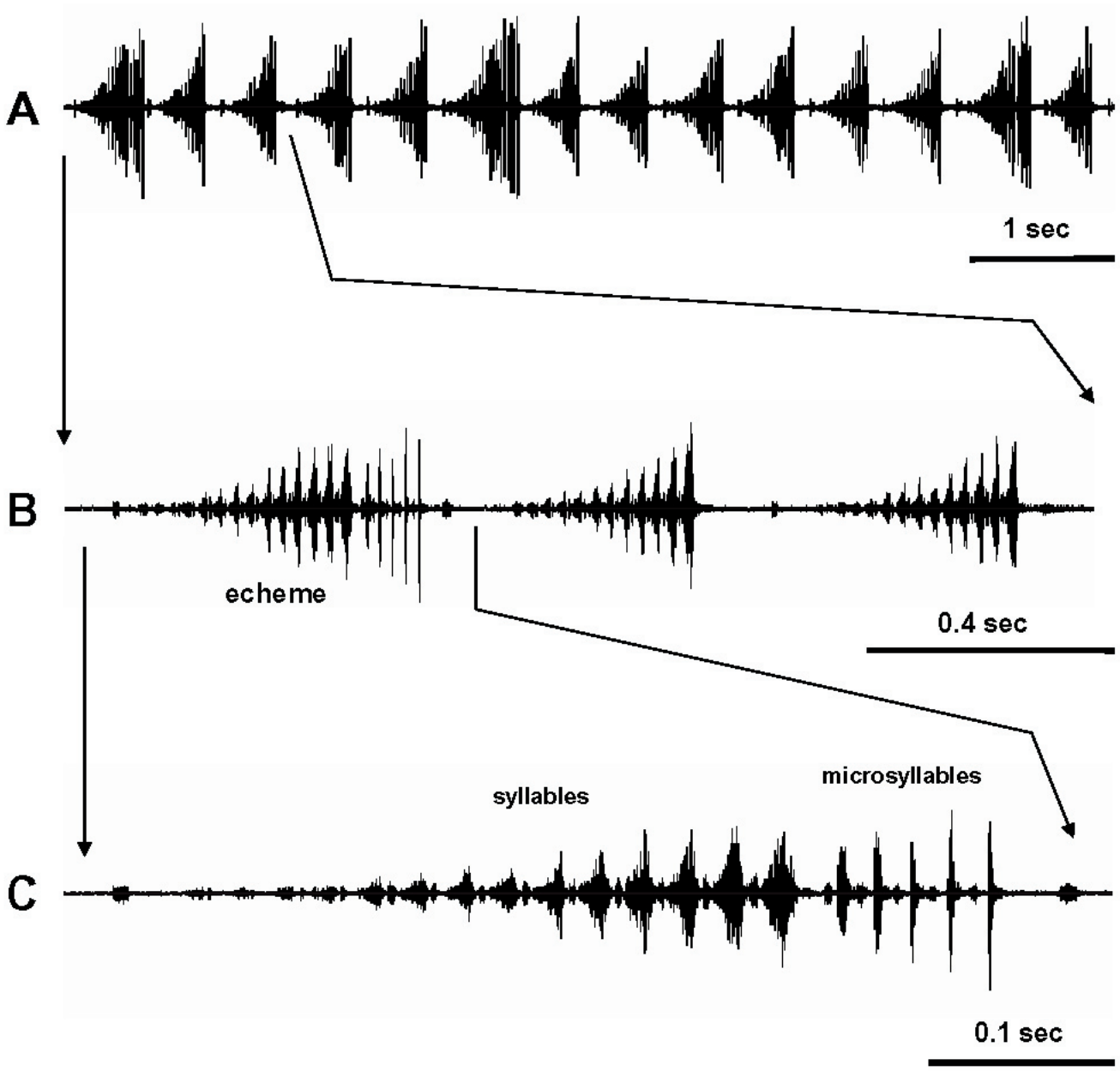


Fig. 4. *Metrioptera c. baccettii*. **A**. Oscillogram of the male calling song, recorded 4.IX.04, h 21:00, 26°C, dark, microphone 90°, file: Met cap bacc CB. **B**. Three echemes at smaller scale. **C**. Echeme at higher resolution.

(Heller 1988), the lowest in *M. c. baccettii* with 58 (Fig. 3A); the number of pegs is 82 in *M. c. caprai* (Fig. 3B).

Compared with the song presented by Ragge and Reynolds (1998) for *M. saussuriana*, possibly the congeneric species most similar to *M. caprai*, the song of *M. caprai baccetii* is slower: it has a lower echeme repetition rate, 1.7 to 2 per s versus 2 to 6 per s, and a longer echeme duration, 0.25 to 0.40 s versus 0.07 to 0.15 s. Both parameters are strongly affected by temperature, but the recordings of *M. saussuriana* were made at equal or lower temperatures than those here presented. The number of syllables per echeme is on average greater in *M. c. baccettii* than in *M. saussuriana*, 9 to 15 *vs* 5 to 10. Syllable repetition rate per s is higher in *M. saussuriana* than in *M. c. baccettii*, being 65 versus 37.5.

In both taxa prolonged echemes are emitted: such echemes are longer in *M. c. baccettii*, about 500 msec versus 150 to 300 msec, and the number of normal echemes between two prolonged ones is apparently lower in *M. c. baccettii* than in *M. saussuriana*, 4 to 18 versus 8 to 25, although the variability is quite large. The number of pegs on the stridulatory file given by Heller (1988) for *M. saussuriana* is higher than for *M. c. baccettii*, being 79 versus 58. Bioacoustic parameters with number of stridulatory pegs are listed in Table 1., where *M. c. lagrecai*, the southernmost subspecies, appears to be the most similar to *M. saussuriana*.

In our opinion these bioacoustic differences, together with the allopatric distribution of the taxa, support the distinct identities of *M. saussuriana* and *M. c. baccettii*, as pointed out by Baccetti (1963) on the basis of morphological characters.

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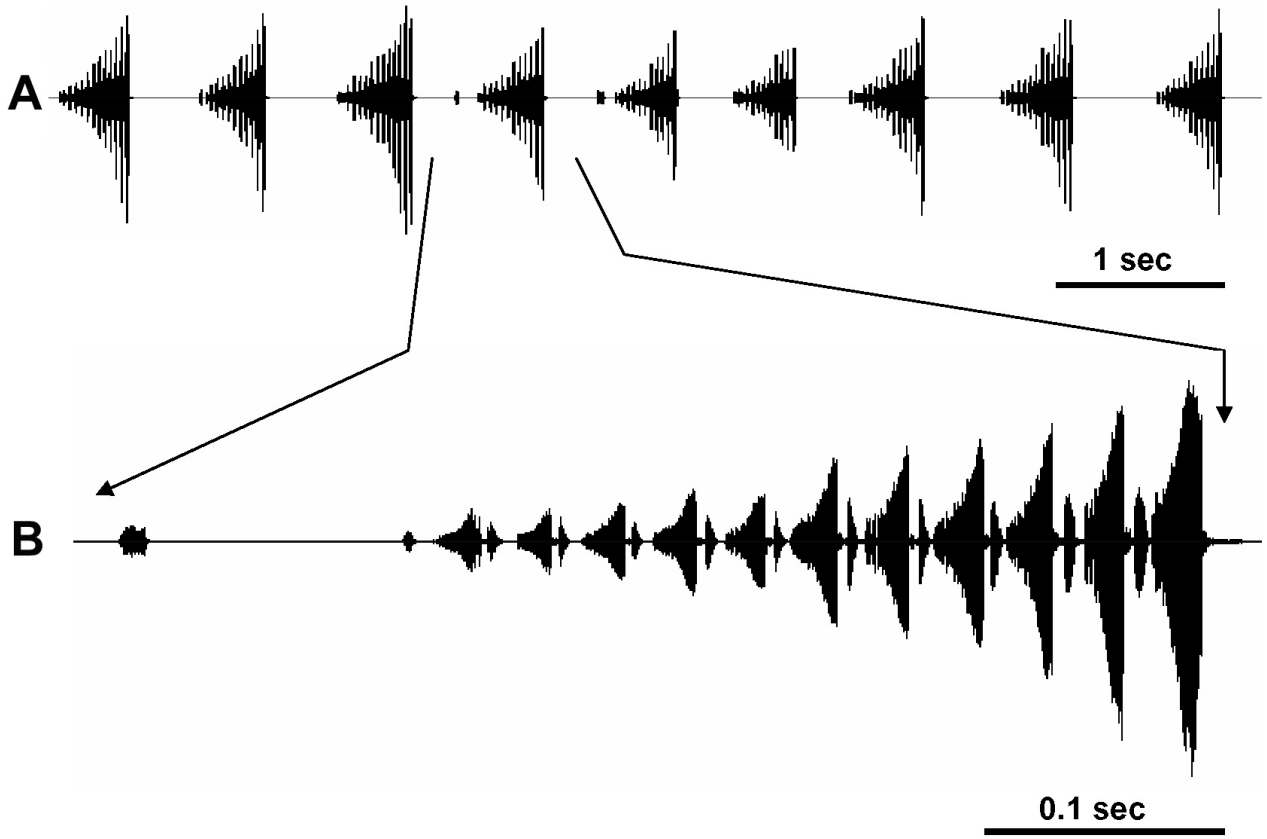


Fig. 5. *Metrioptera c. caprai*. **A**. Oscillogram of the male calling song recorded 2.IX.96, 23°C, file: meca9608_250. **B**. One echeme at higher resolution.

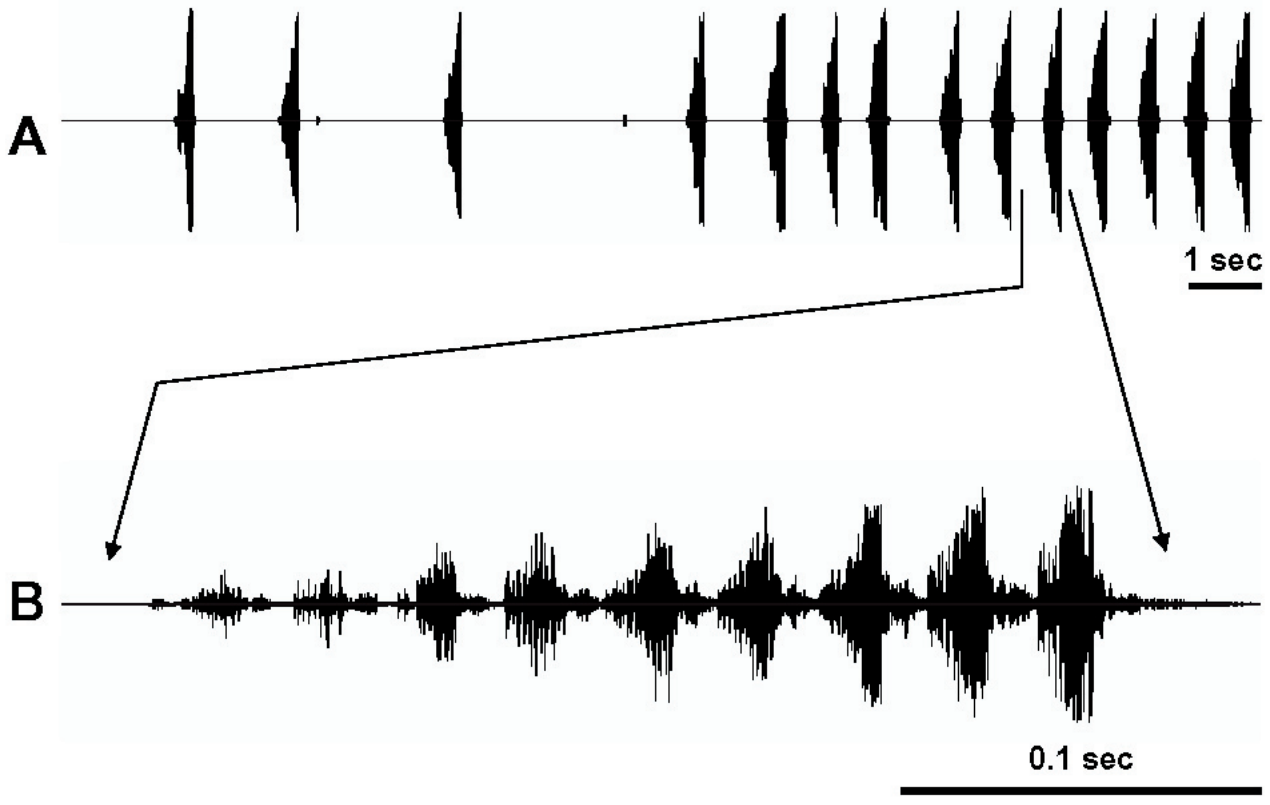


Fig. 6. *Metrioptera c. baccettii*. **A**. Oscillogram of the male calling song recorded 4.IX.04, h 8:00, 25°C, light, microphone 90°, file: Met cap bacc BB. **B**. One echeme at higher resolution.

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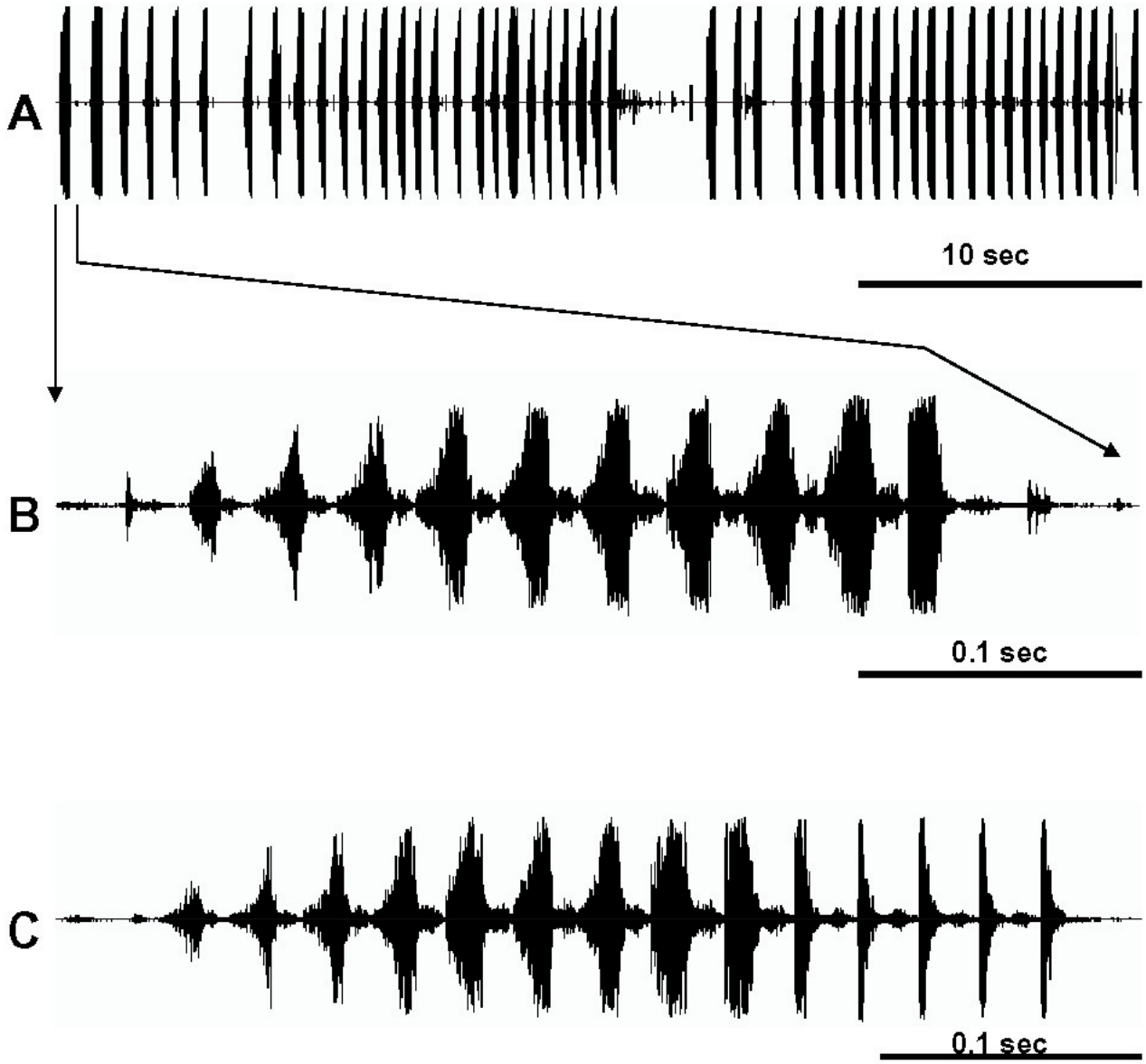


Fig. 7. *Metrioptera c. baccettii*. **A**. Oscillogram of the male calling song recorded 2.IX.04, h 9:00, 24°C, dark, microphone 90°, file: *Metrioptera caprai baccettii* M. Rotondo AB. **B**. First echeme from fig. 7A. **C**. Second echeme from fig. 7A.

Table 1. Bioacoustic parameters and number of stridulatory pegs of *Metrioptera c. capriai*, *M. c. baccetti*, *M. c. lagrecai* and *M. saussuriana.*

	Syllable/ echeme	Syllable rep. rate/s	Echeme rep. rate/s	pegs
M. c. caprai	12	32.5	4.2	82
M. c. baccettii	9-15	37.5	1.7-2	58
M. c. lagrecai	8	60	3	89
M. saussuriana	5-10	65	2-6	79

To date, three populations of *M. caprai baccettii* are known: two in the high valley of Bolognola (the topotypical one in Fonte Bassete and the one on the eastern slope of Monte Rotondo) and one in the high valley of the Ambro river, between 1500 and 1900 m of altitude. At these localities the insects live in habitat where, as noted by Galvagni (1958), *Brachypodium pinnatum* is more abundant (Fig. 1C). Due to the abundance of individuals observed, the populations of *M. c. baccettii* are well characterized, nevertheless, they are extremely localised in relatively small areas and practically absent beyond *Brachypodium* habitat.

Further studies, involving both bioacoustics and morphology, are necessary to clarify the status of the subspecies of *M. caprai* in the Italian Apennines, in order to better understand the identity of the subspecific taxa and so eventually to protect the areas where the populations are settled.

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