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Similar look but different song: a new *Cicadetta* species in the *montana* complex (Insecta, Hemiptera, Cicadidae)

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Abstract

The *Cicadetta montana* species complex includes six cicada species from the West-Palaearctic region. Based on acoustic diagnostic characters, a seventh species *Cicadetta cantilatrix* **sp. nov.** belonging to the complex is described. The type-locality is in France but the species distribution area extends to Poland, Germany, Switzerland, Austria, Slovenia, Macedonia and Montenegro. The calling song sequence consists of two phrases with different echemes. This calling pattern clearly differs from those produced by all other members of the complex, including *C. cerdaniensis*, previously mistaken with the new species. This description increases the acoustic diversity observed within a single cicada genus and supports the hypothesis that sound communication may play a central role in speciation.

Key words: Cryptic species, bioacoustics, Cicadidae, *Cicadetta*, geographic distribution, France

Introduction

Some biodiversity is not obvious when looking at preserved specimens. Various species do not differ in their morphology, but drastically in their behaviour. Such sibling, or cryptic, species are particularly evident in insects that produce sound to communicate: they look similar but sing differently. Many examples of such hidden biodiversity have been reported in Orthoptera, Diptera, Neuroptera and Hemiptera (Henry, 1994; Sueur, 2006). Among Hemiptera, cicadas (family Cicadidae) are well-known for the calling songs they produce during pair formation. Sibling species have been described or confirmed in the following genera based on acoustic criteria: *Lyristes* by Boulard (1988), *Cicadatra* by Popov (1989), *Platypleura* by Villet (1989a; 1989b), *Magicicada* by Marshall & Cooley (2000), *Tosena* by Boulard (2000) and *Cicada* by Quartau & Simões (2005).

Acoustic analysis also revealed several sibling species in the Palaearctic genus *Cicadetta*. These species look similar, are all small in size (body length about 20–30 mm) and all produce high-pitched calling songs (> 11 kHz) that make them difficult to detect and locate. Although several calling songs were reported for *Cicadetta* species living in the eastern Palaearctic region (Popov, 1990; 1997; 1998), acoustics studies were very scarce for the western region including only *C. montana* (*auct. plur.*, *non* Scopoli, 1772), *C. fangoana* Boulard, 1976 and C. *montana* ssp. *macedonica* Schedl, 1999 (Sueur, 2001). In 2000, a new species, *Cicadetta cerdaniensis* Puissant & Boulard, 2000, was discovered in the French Pyrénées (Puissant & Boulard, 2000). Four years later, Gogala & Trilar (2004) undertook a revision of the *montana* species complex. They elevated

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to species level *C. macedonica* Schedl, 1999 and designated the species producing a calling song ended by a separated chirp as *C. brevipennis* Fieber, 1876. This common species was previously misidentified by all authors as *C. montana* (*auct. plur.*, *non* Scopoli, 1772). At the type-locality of *C. montana* they recorded a single species that does not emit a separated ending chirp, and which was recognised as the true *C. montana* (Scopoli, 1772).

Gogala & Trilar (2004) also reported a species from Slovenia which they identified as *C. cerdaniensis*. Similar reports of putative *C. cerdaniensis* were concomitantly or later published from Switzerland (Hertach, 2004), Austria (Trilar & Holzinger, 2004), Germany (A. Staudt *in* Trilar & Holzinger, 2004), Macedonia (Gogala, et al., 2005), Montenegro and Poland (Trilar, et al., 2006). However, the acoustic similarity of the songs described in these reports and the calling song emitted by *C. cerdaniensis* was not clear (Puissant, 2006). We recently found a *Cicadetta* species in France whose calling song we could not identify. This song type clearly differed from all other songs we recorded, in particular from *C. cerdaniensis* calling song, but was very close to the one described in papers reporting *C. cerdaniensis* in other countries. We describe this species here, adding one more species to the *montana* complex which might be even more diverse than first suspected.

Material and methods

Song recordings

Observations were made between the 16th and 29th of June 2006 at Haute-Isle and La Roche-Guyon (Val-d'Oise–95, France). Ambient temperatures in the shade were 24–25°C. Calling songs were recorded using a Sennheiser ME64 cardioid microphone (frequency response: ± 2.5 dB between 0.04 and 20 kHz) connected to a Marantz PMD 670 digital recorder (44.1 kHz sampling frequency, 16 bit precision). Eleven recordings were made, but because calling males could not be caught, it was impossible to know whether these eleven sequences corresponded to eleven individuals or fewer.

Older song recordings made by JS and Jean-Marc Pillet in Martigny-Combes at 24°C (Valais, Switzerland, 5th June 2001), and by Fernand Deroussen in Varzy (Nièvre–58 , France, 15th June 2003) clearly show the same pattern as those made in Haute-Isle and La Roche-Guyon. They were therefore considered conspecific and were added to the sample for analysis.

Because the new species was acoustically very similar to *C. cerdaniensis*, a typical calling song of *C. cerdaniensis* was also analysed. This recording was made by SP in Osséja (Pyrénées-Orientales–66, France, 30th June 2004) at 28°C. Calling songs of *C. cerdaniensis* in Osséja were recorded in the field using an omnidirectional Telinga Pro4PiP microphone (Tobo, Sweden, frequency response 40 – 18 000 Hz ± 1 dB) connected to a Sony TCD-D7 digital audio tape recorder (DAT sampling frequency 48 kHz, frequency response flat within the range 20 – 22 000 Hz ± 1 dB).

To increase the signal to noise ratio, a 4 kHz high-pass frequency filter was applied to the signal. Filtered signals were then analysed using Avisoft signal processing software (Specht, 2004) and Seewave (Sueur et al., 2007), a custom-made library of the 'R' software platform (R Development Core Team, 2004).

Calling songs consisted of the repetition of successive echemes that showed a two-part structure due to a large amplitude modulation. The first part was quiet and the second louder. Echeme duration (*ED*), duration of first echeme part (*FPD*), duration of second echeme part (*SPD*) and inter-echeme duration (*IED*) were measured with a 0.001 s precision on signal oscillograms. Frequency parameters were measured on mean spectra that were computed using sliding short-term Fourier Transforms (STFTs) with a 87.5 % overlap (Hamming window width = 1024 points, frequency resolution = 43 Hz). The dominant frequency was measured for the first echeme part (*FPF*) and the second echeme part (*SPF*). All statistics followed Scherrer (1984) and were run using 'R' software (R Development Core Team, 2004).

Distribution of Cicadetta species in France

This description and the recent new record of *C. montana* (*auct. plur.*, *non* Scopoli, 1772) in France (Sueur & Puissant, 2007) requires reinterpretation of *Cicadetta* species distribution in this country. Several previous records attributed to *C. brevipennis* may in reality represent any species of the *Cicadetta* complex, including species not yet recognised or described. At the moment, the only reliable diagnostic character is calling song structure. New distribution maps were compiled taking into account these caveats, using a database developed and maintained by one of us (SP) and taking into account recent distribution reports (Boitier & Brugel, 2006; Vincent, 2006). Only sites for which the acoustic properties of the population have been published were considered. Consequently, almost no northern and eastern populations could be identified.

Results

Cicadetta cantilatrix sp. nov.

Type material. Holotype male: "Haute-Isle, N 49°05.080', E 001°39.816', Alt. ≈ 55 m" [label rectangular, white, with black margins, manuscript], "16-VI-2006, Val d'Oise (95), France, S. Gadoum & J. Sueur réc." [label rectangular, white, with black margins, manuscript] and "HOLOTYPE ♂, *Cicadetta cantilatrix* n.sp., J. Sueur & S. Puissant" [label rectangular, red, manuscript and printed]. **Paratype female:** "La Roche Guyon, N 49°05.193', E 001°38.535', Alt. ≈ 75 m" [label rectangular, white, with black margins, manuscript], "16-VI-2006, Val d'Oise (95), France, J. Sueur réc." [label rectangular, white, with black margins, manuscript] and "PARATYPE ♀, *Cicadetta cantilatrix* n.sp., J. Sueur & S. Puissant" [label rectangular, red, manuscript and printed]. The holotype and paratype are deposited in the Muséum national d'Histoire naturelle (Paris, France).

Derivation of name. From Latin *cantilo*, meaning "to sing, to hum".

Morphology (Fig. 1). The terminology follows Moulds (2005).

Head: slightly broader than mesonotum; black except epicranial suture, base of median postclypeal fissure, and lateral margins of postclypeus, which are yellowish. Anteclypeus black except that its posterior part may be yellowish. Rostrum with labrum and mentum yellowish, labium black. Apex of rostrum reaching bases of mid trochanter. Gena and lorum black with dense and long silvery hairs. Prominent brownish compound eyes, wider than long. Ocellus yellowish or ochraceous, the distance between lateral ocelli shorter than the distance between each lateral ocellus and the nearest eye. Antennae and supra-antennal plate blackish, margins of pedicel yellowish.

Thorax: pronotum black, sometimes with an interrupted yellowish median line, lateral angle of pronotal collar and pronotal collar black or brownish. Mesonotum black, scutum black or sometimes with a pair of yellow fasciae in an elongated triangular shape, lateral and submedian sigilla black. Metanotum black, cruciform elevation with posterior and anterior branches black or yellowish, mesonotal scutellar cords black with margin yellowish, wing groove black. Pronotum, mesonotum and metanotum blackish with more or less ochraceous margins. Opercula separated, black with a large yellowish posterior margin.

Wings: fore wing hyaline with eight apical cells, sometimes with a ninth aberrant apical cell and with aberrant median and aberrant radial anterior veins. Wing nervation yellowish except apical cells and a part of ulnar cells, which are blackish. Median and cubital anterior vein shortly fused at their bases, veins not aligned. Hind wing with six apical cells, sometimes with a seventh aberrant apical cell and aberrant median veins. Venation blackish to brownish, ambient vein blackish, vannus hyaline with margins blackish, plaga and anterior margin of jugum brownish with blackish spot inside jugum.

Legs: yellowish-brownish and black. Fore legs with coxa black, their margins more or less brownish; trochanter black with posterior margin slightly brownish; femur with anterior side black and yellowish spot more or less expanded, posterior side brownish except a blackish spot inside, three spines black, the primary spine

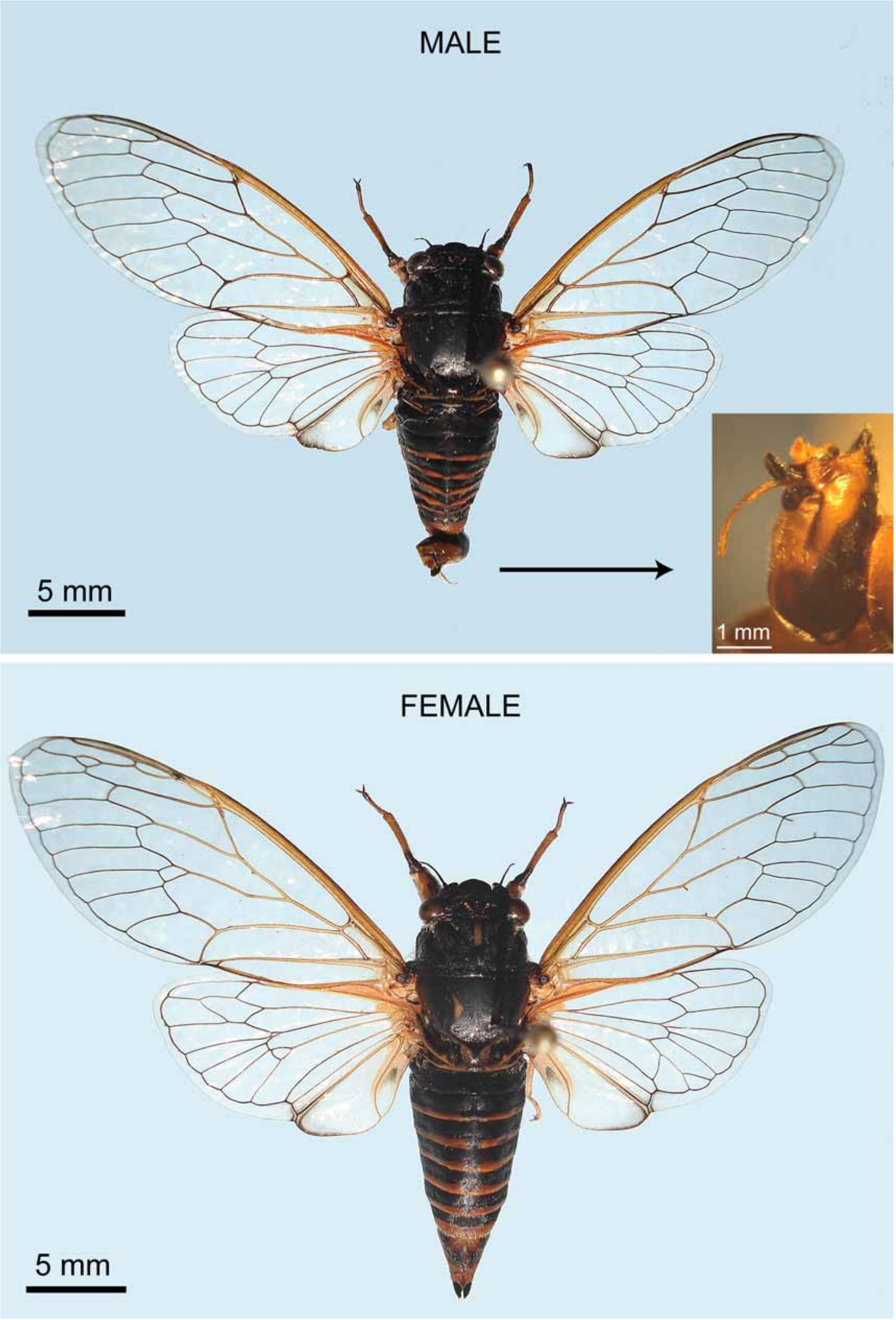


FIGURE 1. Dorsal view of *C. cantilatrix* **sp. nov.**: male holotype with a lateral view of the genitalia (inset) and female paratype.

strong and oblique, isolated from the two others, the secondary sharp and sub-perpendicular, the apical spine short and triangular; tibia yellowish with the posterior margin black; tarsus yellowish with pretarsal claw blackish. Mid legs with coxa black except the latero-posterior side sometimes brownish, its apical border yellowish; trochanter black with base and ventral margin more or less brownish; femur brownish with blackish longitudinal stripe of variable width; tibia yellowish; tarsus yellowish with claw blackish. Hind legs similar to mid legs or lighter in colour.

Abdomen: tergites black with posterior margins orange, auditory capsules sub-circular, convex and black. Tymbal bearing a series of three long ribs, alternating with three very short ribs, the three long ribs connected by a dorsal bar and running dorsoventrally to the tymbal plate. Sternites orange with an antero-median spot more or less wide, that gradually narrows to the apex of the abdomen.

Genitalia: pygofer curved with an upper lobe rounded, moderately developed, distant from dorsal beak. Median lobe of uncus curved upwards, clasper hooked. Thecal pseudoparameres filiform and much longer than theca, originating near thecal base.

Body measurements: Only two specimens, a male and a female, are available. The first value refers to the male and the second to the female. Measures are in millimetres. Length of body: 17.1 – 21.6. Length of fore wing: 19.9 – 21.6. Width of fore wing: 7.6 – 9.2. Length of head: 1.3 – 1.9. Width of head, eyes included: 5.0 – 5.8. Width of pronotum, supra-humeral plate included: 6.3 – 6.9. Width of mesonotum: 5.5 – 6.0.

Acoustic behaviour (Figs. 2–4). A typical calling song sequence consists of two alternating phrases: one phrase of short echemes produced at a slow rate (short echeme duration [*ED*], long inter-echeme duration [*IED*]) and the other of long echemes emitted at a faster rate (long *ED*, short *IED*) (Fig. 2A,B, Table 1). The histogram and density function of *ED* show a bimodal distribution with negative kurtosis ($s_4 = -1.29$) (Fig. 3). This confirms the production of two distinct categories of echemes with short and long duration respectively. The majority of echemes (99 %) are made of two parts: the echeme starts with a quiet part and finishes with a loud part. First part duration (*FPD*) shows a bimodal distribution similar to that of *ED* with similar negative kurtosis ($s_4 = -1.31$). *ED* and *FPD* are in fact highly correlated (Spearman’s rank correlation: R= 0.999, $p < 2.2*10^{-16}$).

TABLE 1. Temporal parameters of *C. cantilatrix* **sp. nov.** and *C. cerdaniensis* calling songs. Mean ± sd. n = number of echemes. *ED* = echeme duration, *IED* = inter-echeme duration, *FPD* = first echeme part duration, *SPD* = second echeme part duration, *FPF* = first echeme part frequency, *SPF* = second echeme part frequency.

	ED (s)	IED (s)	FPD (s)	SPD (s)	FPF (kHz)	SPF (kHz)
C. cantilatrix **sp. nov.**						
Phrase 1 (n=184)	0.169 ± 0.149	0.972 ± 0.522	0.146 ± 0.143	0.023 ± 0.010	13.478 ± 1.060	13.612 ± 0.939
Phrase 2 (n=406)	0.458 ± 0.185	0.437 ± 0.244	0.427 ± 0.183	0.031 ± 0.008	13.133 ± 0.982	13.575 ± 1.005
All (n=590)	0.368 ± 0.220	0.604 ± 0.433	0.339 ± 0.215	0.028 ± 0.010	13.240 ± 1.018	13.586 ± 0.985
C. cerdaniensis						
Phrase 1 (n=75)	0.044 ± 0.010	0.844 ± 0.214	0.016 ± 0.007	0.027 ± 0.004	15.442 ± 0.233	15.473 ± 0.223
Phrase 2 (n=85)	0.12 ± 0.043	1.037 ± 0.196	0.085 ± 0.040	0.036 ± 0.004	15.299 ± 0.299	15.541 ± 0.293
Phrase 3 (n=333)	0.038 ± 0.005	0.233 ± 0.088	0.012 ± 0.040	0.026 ± 0.005	15.514 ± 0.419	15.515 ± 0.418
All (n=493)	0.053 ± 0.036	0.464 ± 0.365	0.025 ± 0.032	0.028 ± 0.006	15.470 ± 0.386	15.510 ± 0.375

In the frequency domain, most of the spectral energy is between 11 kHz and 18 kHz. The dominant frequency is not constant but does not show a clear modulation pattern (Fig. 4), and is on average around 13 kHz (Table 1). The dominant frequency of the first echeme part (*FPF*) is slightly but significantly lower than that of the second part (*SPF*) (Wilcoxon test for paired samples, V = 40689.5, $p = 3.57*10^{-16}$).

Habitat (Fig. 5). In Haute-Isle and La Roche-Guyon, *C. cantilatrix* **sp. nov.** inhabits closed grassland on Seine River slopes. The two stations consist of axeric vegetation belonging to the sub-xeric class and temperate subclass (SX3) following Defaut’s phytoclimatic classification (Defaut, 1996; 2001). In one site, *C. canti-*

latrix **sp. nov.** shares the habitat with *C. brevipennis*. Their emergence periods seem to be slightly shifted, *C. cantilatrix* **sp. nov.** appearing before *C. brevipennis*.

Distribution (Fig. 8). In France, the species is also present in Bourgogne (Nièvre). Due to their evident acoustic similarities and distribution pattern, the records of *C. cerdaniensis* in Slovenia (Gogala & Trilar, 2004), Switzerland (Hertach, 2004), Austria (Trilar & Holzinger, 2004), Germany (A. Staudt *in* Trilar & Holzinger, 2004), Macedonia (Gogala, et al., 2005), Montenegro and Poland (Trilar, et al., 2006), can now be attributed to *C. cantilatrix* **sp. nov.**

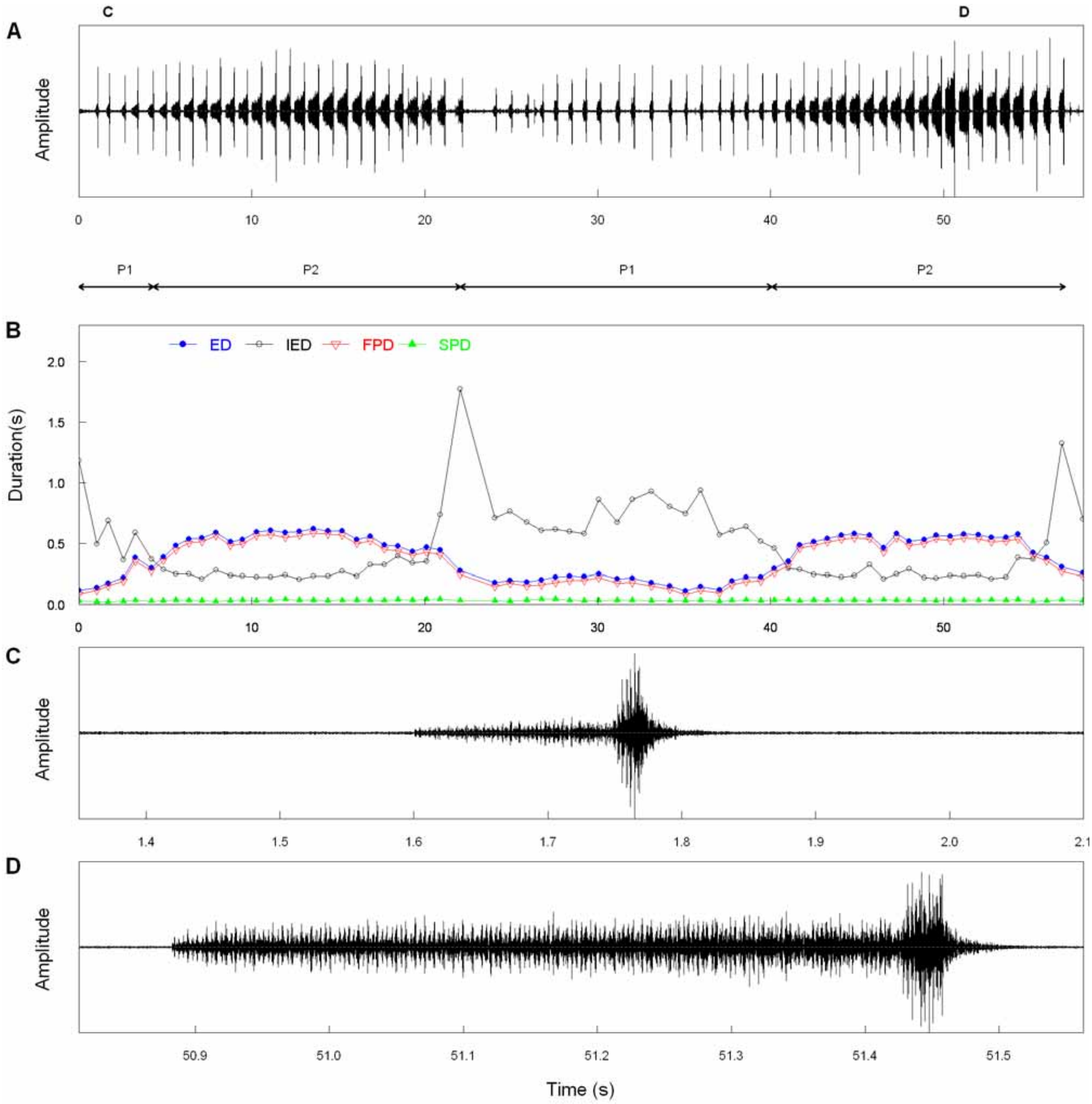


FIGURE 2A–D. Temporal pattern of *C. cantilatrix* **sp. nov.** calling song. A, Oscillogram (time *vs* amplitude) of two typical sequences, each made of two phrases (P1, P2) with short and long echemes respectively, letters refer to time windows depicted in C and D; B, Variations of temporal parameters along sequences. When *ED* increases *IED* decreases and vice versa. *FPD* covaries with *ED* while *SPD* remains constant. Longer *IED* values separate successive sequences; C, Oscillogram of a typical short echeme produced during phrase 1 (P1); D, Oscillogram of a typical long echeme produced during phrase 2 (P2). *ED* = echeme duration, *IED* = inter-echeme duration, *FPD* = first echeme part duration, *SPD* = second echeme part duration.

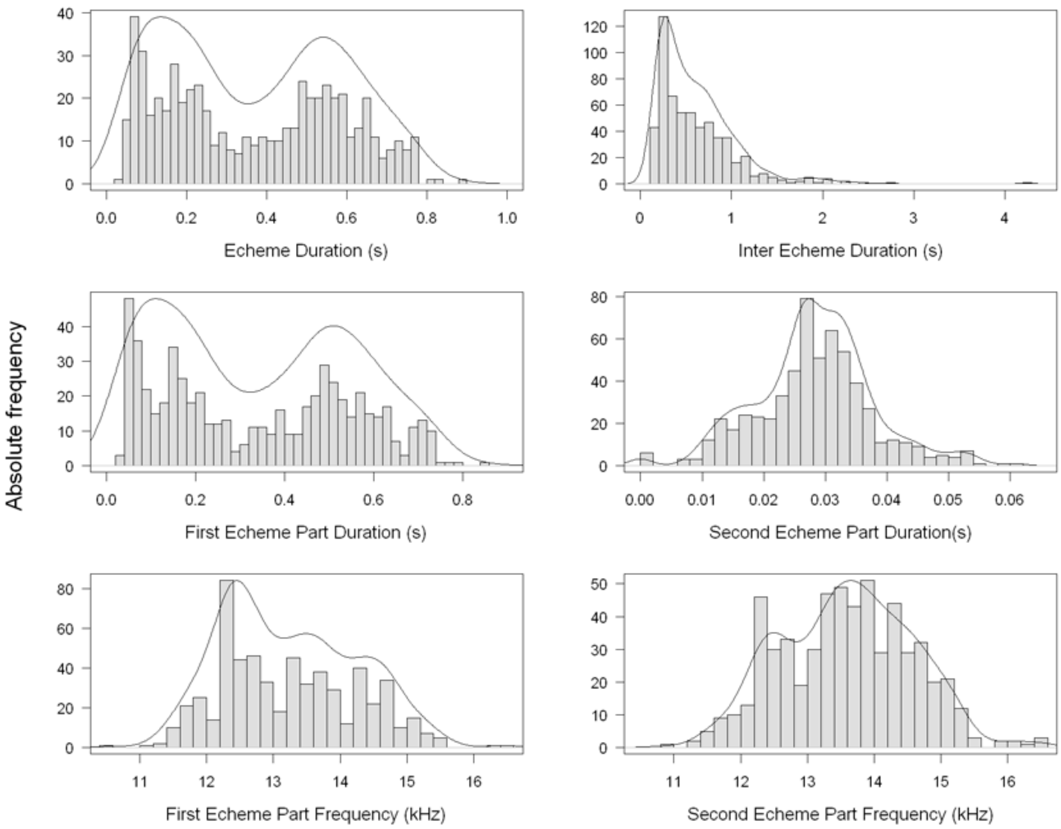


FIGURE 3. Temporal and frequency characteristics of *C. cantilatrix* **sp. nov.** calling song. Density distributions were estimated using Gaussian kernel smoothing and plotted over histograms.

C. cerdaniensis calling song

Because *C. cantilatrix* **sp. nov.** and *C. cerdaniensis* calling songs have been previously mistaken, we here provide a description of a typical sound emission produced by *C. cerdaniensis* male. Echemes emitted by *C. cerdaniensis* basically follow the same pattern as those produced by *C. cantilatrix* **sp. nov.** However, as stated in the original description (Puissant & Boulard, 2000), a typical calling sequence of *C. cerdaniensis* includes three phrases differing in echeme production rate (Figure 6A). All temporal parameters (*ED*, *FPD*, *SPD*, *IED*) covary (Figure 6B). The first phrase is made of short echemes produced at high rate (short *ED*, short *FPD*, short *SPD*, short *IED*, Figure 6C). Then, during the second phrase, echemes lengthen and the gaps between them also increase (long *ED*, long *FPD*, long *SPD*, long *IED*, Figure 6D). The third phrase is characterised by the emission of short echemes at a very high rate (short *ED*, short *FPD*, short, *SPD*, very short *IED*, Figure 6E).

In the frequency domain, most of the spectral energy is between 12 kHz and 19 kHz, but the dominant frequency is around 15 kHz, higher than that of C. *cantilatrix* **sp. nov.** (Table 1, Figure 7).

List of cicada species (family Cicadidae) and distribution of *Cicadetta* species in France

Following the new higher classification of cicadas (Moulds, 2005) and the new information on *Cicadetta* species, here is provided a complete list of the 19 cicada taxa known to occur in France (mainland and Corsica island):

-Cicadinae, Cryptotympanini: *Lyristes plebejus* (Scopoli, 1763)
-Cicadinae, Cicadini: *Cicada orni* Linné, 1758; *Cicadatra atra* (Olivier, 1790)
-Tettigadinae, Tibicinini: *Tibicina haematodes* (Scopoli, 1763); *T. tomentosa* (Olivier, 1790); *T. steveni* (Krynicki, 1837); *T. corsica corsica* (Rambur, 1840) [Corsica]; *T. quadrisignata* (Hagen 1855); *T. nigronervosa* Fieber, 1876 [Corsica]; *T. corsica fairmairei* Boulard, 1980; *T. garricola* Boulard, 1983
-Cicadettinae, Cicadettini: *Cicadetta montana* (Scopoli, 1772); *C. brevipennis* Fieber, 1876; *C. fangoana* Boulard, 1976 [Corsica]; *C. cerdaniensis* Puissant & Boulard, 2000; *C. cantilatrix* **sp. nov.**; *Cicadivetta tibialis* (Panzer, 1798); *Tettigetta argentata* (Olivier, 1790); *T. pygmea* (Olivier, 1790).

Distribution maps of French *Cicadetta* species are given in Figure 8.

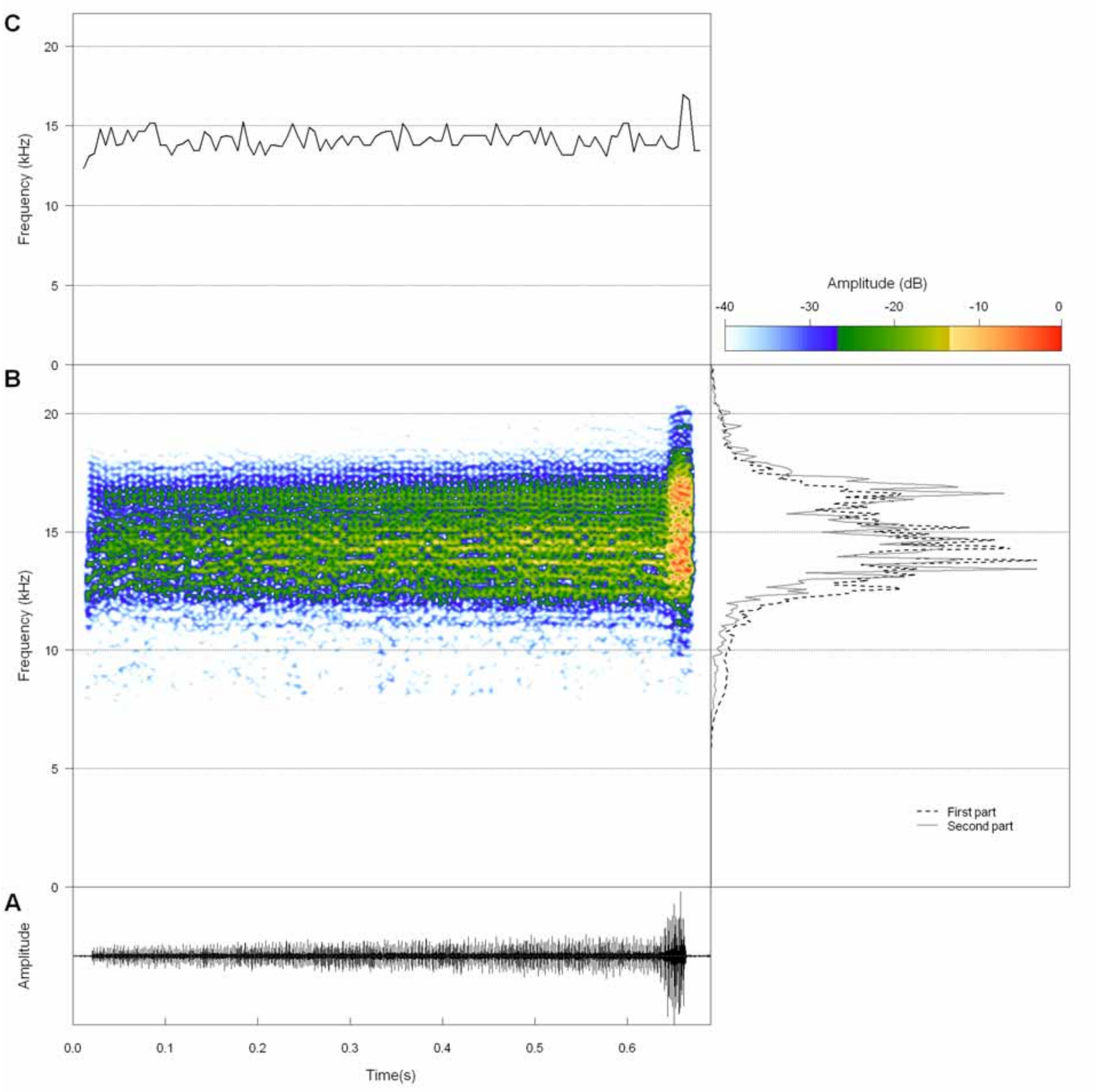


FIGURE 4 A–C. Frequency pattern of a typical long echeme produced by *C. cantilatrix* **sp. nov.** A, Oscillogram; B, Spectrogram (time *vs* frequency *vs* amplitude, colour amplitude scale given on the right) and mean spectrum (frequency *vs* amplitude) of the first and second parts of the echeme; C, Dominant frequency variation along the echeme. Frequency analysis parameters: Hamming window, overlap = 87.5%, frequency resolution = 43 Hz. Short echeme showed similar frequency parameters.

FIGURE 5. Type-locality habitat of *C. cantilatrix* **sp. nov.** Males were mainly found calling in trees and bushes.

Discussion

Usefulness of acoustics for insect taxonomy has been demonstrated several times: species have been discovered, confirmed or reconsidered thanks to the analysis of sound produced during pair formation (Sueur, 2006). The distinction of this new *Cicadetta* species, based on acoustic characters only, proves again that behavioural analyses may be crucial for biodiversity assessment and systematics investigations.

The calling song of *C. cantilatrix* **sp. nov.** shows a unique pattern, differing greatly from all other *Cicadetta* species sound emissions (Gogala & Trilar, 2004). *C. cerdaniensis* produces acoustic signals similarly made of short echemes with a large final amplitude modulation. However, echemes produced by *C. cantilatrix* **sp. nov.** are longer (around 0.37 s *vs* around 0.05 s), emitted at a distinct rhythm (sequences made of two parts *vs* three parts) and have a lower dominant frequency (around 13.6 kHz *vs* 15.5 kHz). These differences are here used as diagnostic characters to discriminate species. Do the females use the same parameters to distinguish conspecific from allospecific calling males? They might in fact not have to face such a situation in natural conditions because *C. cerdaniensis* seems to occur in south-west Europe (south of France and north of Spain: Puissant, 2006) while *C. cantilatrix* **sp. nov.** occurs only in the north-east of Europe. The north-east limit of the distribution of *C. cerdaniensis* is probably along the east of the French Pyrénées, and the south-west limit of *C. cantilatrix* **sp. nov.** is apparently in northern France but is currently difficult to estimate precisely. These two species are therefore distributed allopatrically. Isolation between *C. cantilatrix* **sp. nov.** and *C. cerdaniensis* would then be by geography rather than acoustics.

In the case of *C. cantilatrix* **sp. nov.** and *C. brevipennis*, other factors probably contribute in preventing hybridization since these species are sympatric. Their respective calling songs are so divergent that they surely play a significant role in bringing conspecific sexes together. In addition, *C. cantilatrix* **sp. nov.** was always heard calling from bushes and trees while at the same site *C. brevipennis* occupied the lowest strata of the habitat, males being positioned on herbaceous plants, an unusual calling position for this species, which is usually found at all levels in the habitat (Puissant, 2006). This calling position might decrease the risk of acoustic interference between species. Although this needs to be documented over several successive years, these two species might not appear in the same time, since adults of *C. cantilatrix* **sp. nov.** apparently emerge earlier than those of *C. brevipennis*. Acoustic divergence, habitat selection and allochrony could then ensure isolation altogether. As previously reported for *Tibicina* species (Sueur & Aubin, 2003; 2004; Sueur & Puissant, 2002), there would be then a combination of factors ensuring pre-zygotic isolation between species of the *Cicadetta montana* complex.

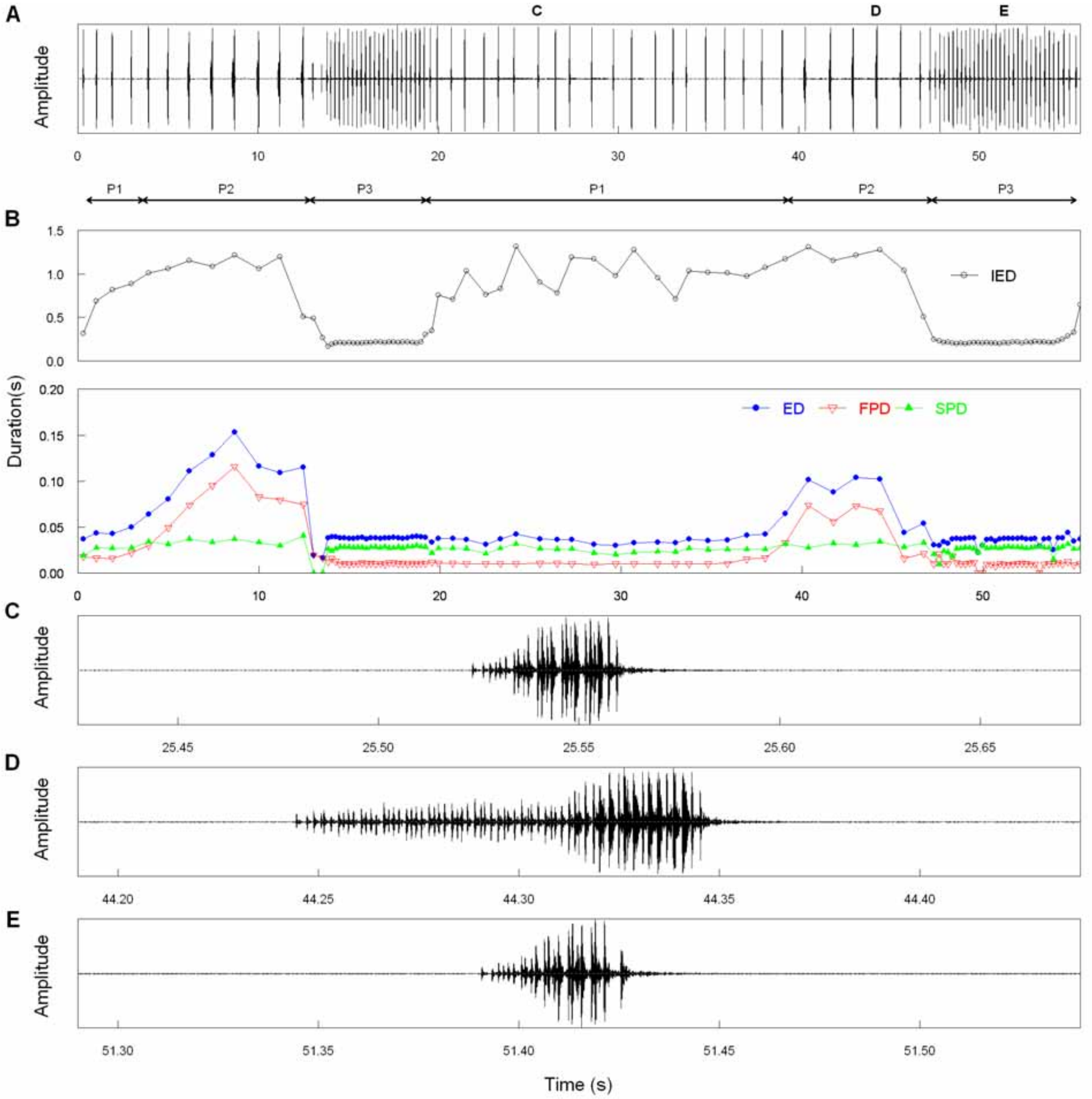


FIGURE 6 A–E. Temporal pattern of *C. cerdaniensis* calling song. A, Oscillogram (time *vs* amplitude) of two typical sequences, each made of three phrases (P1, P2, P3). Letters refer to temporal zooms depicted in C, D and E; B, Variations of temporal parameters along the phrases. *ED*, *EID*, *FPD* and *SPD* covary. C, Oscillogram of a typical echeme produced during phrase 1 (P1); D, Oscillogram of a typical echeme produced during phrase 2 (P2); E, Oscillogram of a typical echeme produced during phrase 3 (P3). Abbreviations as in figure 2.

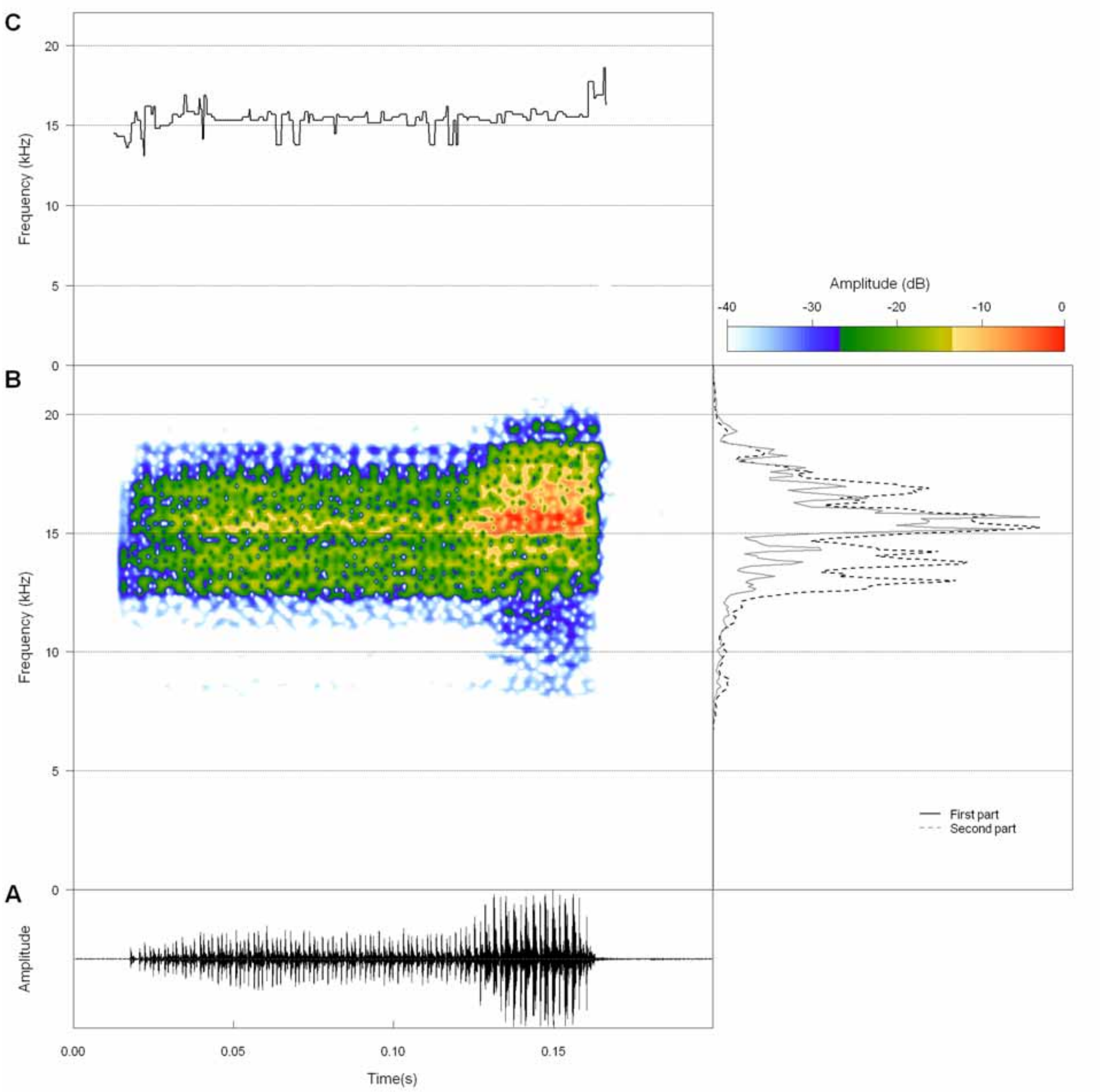
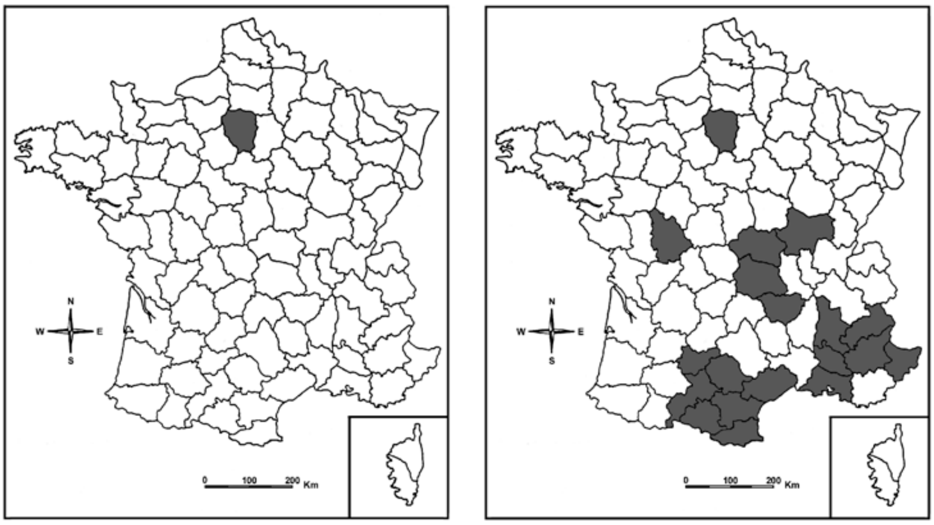


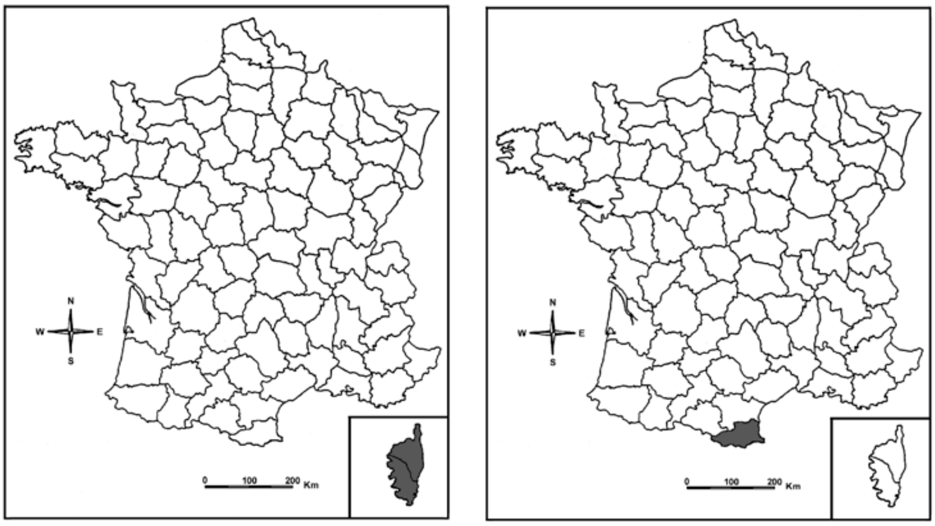
FIGURE 7 A–C. Frequency pattern of a typical long echeme produced by *C. cerdaniensis.* A, Oscillogram; B, Spectrogram (time *vs* frequency *vs* amplitude, colour amplitude scale given on the right) and mean spectrum (frequency *vs* amplitude) of the first and second parts of the echeme. C, Dominant frequency variation along the echeme. Parameters as in figure 6.

With this new species, the *Cicadetta montana* complex now contains seven taxa: *C. montana*; *C. concinna* (Germar, 1821) (= *C. podolica* Eichwald, 1830); *C. brevipennis*; *C. fangoana*; *C. macedonica*; *C. cerdaniensis* and *C. cantilatrix* **sp. nov.** The calling songs of these species mainly differ in their temporal pattern but not radically in their frequency properties. This frequency homogeneity can be related to their morphological similarity. All species fall into the same body length range (about 20–30 mm). Since size and frequency of sound emitted are usually negatively correlated (Bennet-Clark, 1998; Bennet-Clark & Young, 1994), they all experience identical mechanical constraints and consequently produce sound over the same frequency bandwidth (12–18 kHz). Probably due to these intrinsic limitations, sexual selection principally could have taken effect on time and amplitude variations.



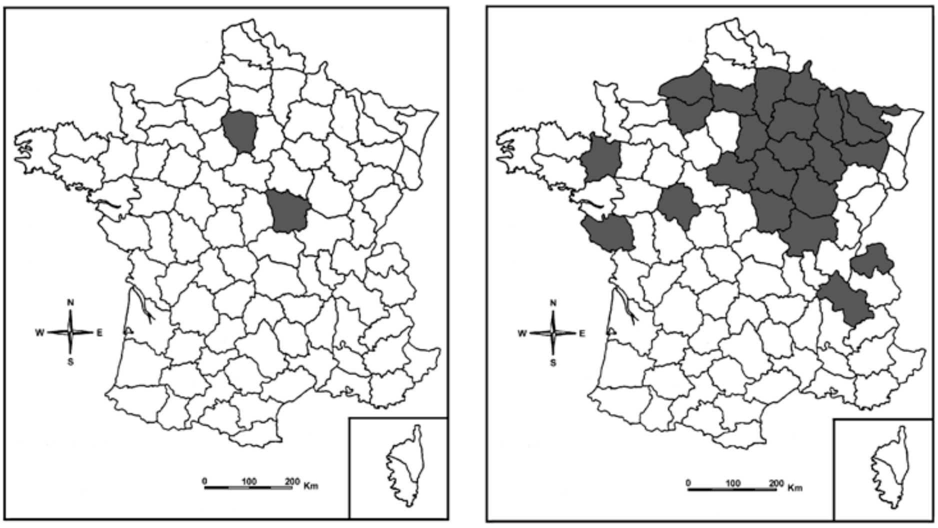
C. montana Scopoli, 1772

C. brevipennis Fieber, 1876



C. fangoana Boulard, 1976

C. cerdaniensis Puissant & Boulard, 2000



C. cantilatrix n. sp.

C. cf. *montana*

FIGURE 8. Distribution maps of *Cicadetta* species in France including Corsica (inset). Internal borders follow administrative divisions (“départements”). *Cicadetta* cf. *montana* refer to specimens of the complex that could not be determined at species level because of unavailable acoustic information.

Like treehoppers (Rodríguez, et al., 2004), crickets (Mendelson & Shaw, 2005) or lacewings (Henry, 2006), *Cicadetta* species might provide a new interesting model for the study of acoustic signal evolution and the importance of communication in the emergence of new species (Boughman, 2002; Butlin, 1995; Villet, 1995). More data have to be gathered on acoustic traits and more generally on sexual behaviour, but also on distribution, ecology, phenology and genetic diversity. Phylogeny reconstructions of extant species are very helpful in estimating the selective forces that led to such a high cryptic diversification (Buckley, et al., 2006).

It is noteworthy that in the locality where we investigated, *C. cantilatrix* **sp. nov.** occupies mainly open and closed high shrubland belonging to SX3 phytoclimatic class. This phytoclimatic context presumably results of old pastoral activities. A decline of these human activities would lead to habitat change towards a colder phytoclimatic class (woodland: Cc) and might endanger cicada populations.

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