Dtsch. Entomol. Z. 55 (1) 2008, 91–100 / DOI 10.1002/mmnd.200800006

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Cicadetta montana complex (Hemiptera, Cicadidae) in Greece – a new species and new records based on bioacoustics

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Received 26 July 2007
Accepted 19 October 2007
Published 19 May 2008

Key Words

Cicadetta hannekeae sp. n.
C. macedonica
Songs
Singing cicadas

Abstract

In the mountains of Central Greece (Mt. Parnassos, Mt. Giona, Mt. Iti), in the Peloponnesus (Mt. Menalo, Mt. Parnon, Mt. Chelmos, Mt. Panachaiko, Pteri) and in Epirus (South Pindos, Katara Pass), a new species of *Cicadetta montana* complex has been discovered. *Cicadetta hannekeae* sp. n. is morphologically very similar to other species of this complex but has a characteristic and distinct song. This species was found at elevations from 800 to 1700 m and apparently replaces in these localities *C. macedonica* and *C. montana* s. str., found in the Southern Balkans (North Pindos, Mt. Vourinos, Mt. Galičica, Mt. Pelister, Radika Gorge and Suva Planina).

Introduction

With the introduction of bioacoustic methods into investigations of cicadas (Cicadidae sensu Moulds, 2005) many new species were described and species complexes recognized worldwide (e.g. Alexander & Moore 1958; Cooley & Marshall 2001; Ewart 2005; Boulard 2006a, 2006b). This is true also for European cicadas, especially for the *Cicadetta montana* complex of close related species (e.g. Schedl 1999; Gogala & Trilar 1999, 2004; Puissant & Boulard 2000; Trilar & Holzinger 2004; Sueur & Puissant 2007a, 2007b; Hertach 2007). By bioacoustic methods it is also much easier to single out singing animals in vegetation and to identify them.

Till now there is no comprehensive paper on the Cicadidae of Greece. Nevertheless, some authors studied recently also with acoustic methods some genera of cicadas (e.g. Quartau & Simões 2006, Drosopoulos et al. 2006). However, the fauna of mountain cicadas has not been investigated in Greece thoroughly with bioacoustic methods. Cicadas of this group have been recently investigated in France (Puissant & Boulard 2000; Sueur & Puissant 2007a, 2007b), Slovenia (Gogala & Trilar 2004), Switzerland (Hertach 2007), Poland (Trilar et al. 2006b), Austria (Trilar & Holzinger 2005), and the Balkans (Gogala et al. 2005; Trilar et al. 2006a), but there were no data about the geographic distribution of *C. montana* and related species in Greece. Therefore, we devoted during our investigations special attention to species of the *Cicadetta montana* complex.

Materials and methods

Two of us (MG & SD) made field trips through central Greece and eastern part of Peloponnesus (from 19. to 26.06.2004 and from 6. to 12.06.2005). We all investigated Mt. Menalo on Peloponnesus (28.06.2006), places near Panourgias at the deviation to Pyra between Mt. Giona and Mt. Iti in Fokida, South Pindos near the Plastiras lake (30.06.2006), Mt. Vourinos and North Pindos near Pentalofos (01.07.2006) and Katara Pass near Metsovo (03.07.2006). Eventually, we visited Mt. Pilion near Volos (05.07.2007) and Mt. Othris above Lamia (07.07.2007). For the names and spelling of localities we follow the transliterations used in Fauna Graeciae I (Willemse 1984, 1985b).

For acoustic detection and recording of songs we used the following equipment: an ultrasonic detector Pettersson D-200 with a microphone mounted in front of a Telinga reflector and the solid state re-

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corders Marantz PMD-670 and Marantz PMD-660. In the year 2004, we also used a Sony DAT recorder TCD-D10. For analyses of sound we used Raven 1.2 (Cornell Lab of Ornithology), Canary 1.4 (Cornell Lab of Ornithology) and Amadaeus (HairerSoft) softwares. We first localized cicadas acoustically and then collected them with an entomological net. We made morphological investigations on dry prepared specimens. Higher classification and morphological terminology are after Moulds (2005).

The type series and other dry prepared specimens are deposited in the collection of the Slovenian Museum of Natural History (PMSL) and in the collection of S. Drosopoulos. One specimen from Mt. Parnassos was preserved in the absolute alcohol for molecular investigation achieved by Chris Simon and coworkers (University of Connecticut, USA).

Results

One of us (SD) observed some years ago in the valley below Mt. Parnassos (cca. 1500 m above sea level) small cicadas resembling *Cicadetta montana* (Scopoli, 1772), sitting on the ground on reddish sand on the banks of a small stream and singing. One of these specimens is now in Drosopoulos collection.

We visited this place in 2005 and on June the 7th we first acoustically detected and collected some cicadas. It turned out that the song differs from all previously known song patterns of European singing cicadas (Puis-

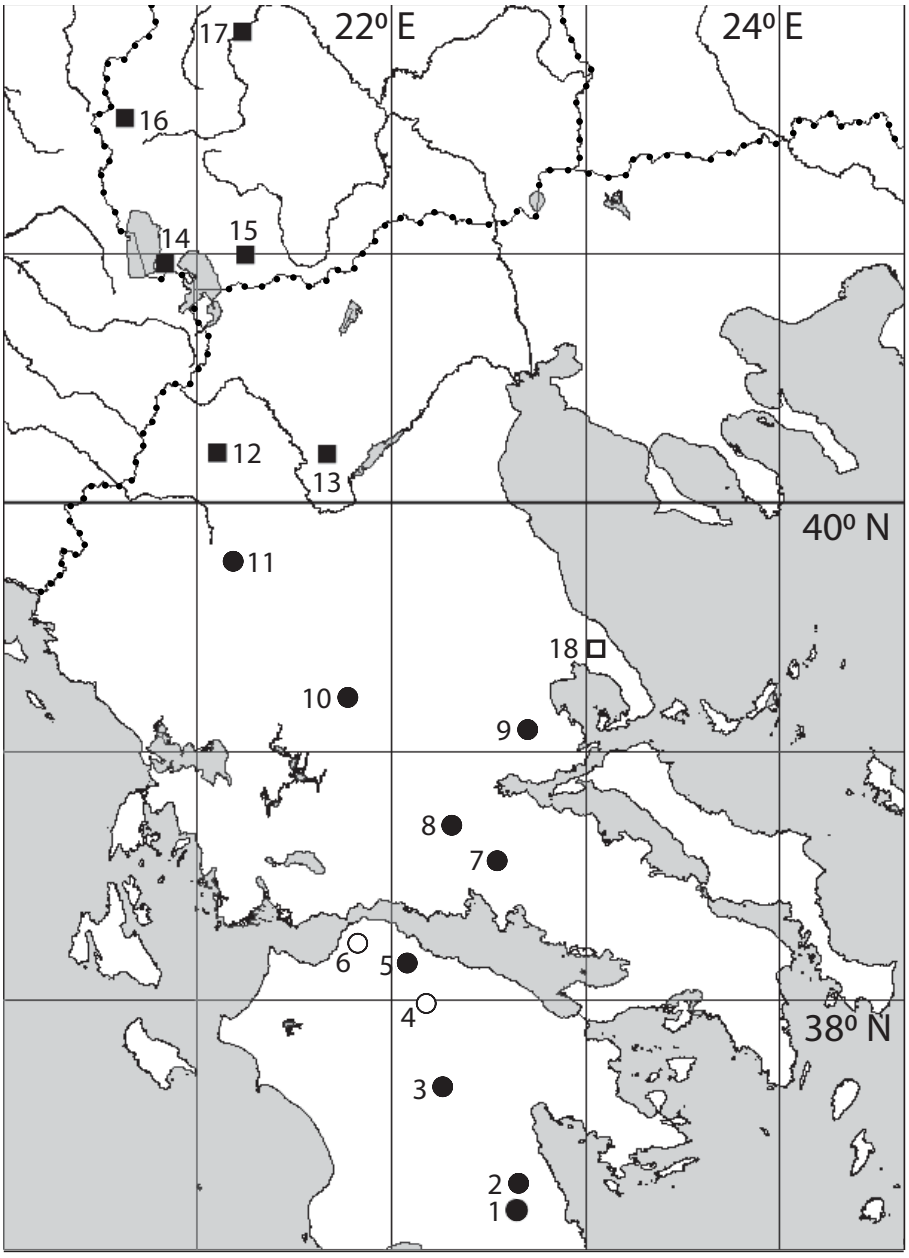


Figure 1. Geographic distribution of the close related species *Cicadetta hannekeae* sp. n. (black circles) and *Cicadetta macedonica* together with *Cicadetta montana* (black squares). On Mt. Pilion only *C. montana* was found (open square). Two localities on Peloponnese are documented only with specimens without recordings of the sound emissions (open circles). 1 Kastanitsa, 2 Mt. Parnon, 3 Mt. Menalo, 4 Mt. Chelmos, 5 Pteri (Fteri), 6 Mt. Panachaikon, 7 Parnas, Eptalophos, 8 Mt. Iti, Panourgias, Stromi, 9 Mt. Othris, 10 S. Pindos, Moucha, 11 Metsovo, Katara pass, 12 N. Pindos, Pentalofos, 13 Mt. Vourinos, 14 Mt. Galičica, 15 Mt. Pelister, 16 Radika gorge, 17 Suva Planina, 18 Mt. Pilion.

sant & Boulard, 2000; Gogala & Trilar, 2004; Sueur & Puissant, 2007b) inclusive *Cicadetta macedonica* (Schedl, 1999; Gogala & Trilar, 1999), despite similarities with the latter (see below). The next locality, where the same species has been found, was above the village Eptalofos not far from the Parnassos region. We found the same species also in the region of Mt. Giona and Mt. Iti in localities between village Stromi (900 m), near Panourgias at deviation to Pyra and on the Mt. Iti up to the elevation of 1600 m. Later we found the same species also on Peloponnesus near the village Pteri (Fteri – 1200 m), Kastanitza and on Mt. Parnon (in places with elevation between 1300 to 1700 m) and in the year 2006 on Mt. Menalo (around 1600 m). During the field trip in 2006 we acoustically confirmed the presence of this species and collected some specimens also farther to the North on South Pindos near the village Moucha (above the southeastern part of lake Plastiras, between 950 and 1100 m) and on the Katara Pass near Metsovo (1300–1400 m). During the field work in 2007 we detected this species also on Mt. Othris (1150 m) (for localities see Fig. 1).

Records of other species of *C. montana* complex

During the field trip in 2006 and in former years we found and recorded in the mountains north of the 40° N latitude (Mt. Vourinos and North Pindos near Pentalofos, 1250–1400 m) *C. montana* s. str. and *C. macedonica* in mixed populations (Fig. 1, localities 12–17) (Gogala et al. 2005). However, during the field work in 2007 we detected on Mt. Pilion (Fig. 1, locality 18), south of 40° latitude *C. montana* s. str., but not *C. macedonica* or *C. hannekeae*. Characteristic for this locality are beech forests (*Fagus sylvatica*).

Description of *Cicadetta hannekeae* sp. nova

The song pattern: Time parameters

The calling song consists of three segments, together forming a complete song with typical average duration of more than a minute. The shortest song recorded lasted 16 s and the longest one over 2 minutes. Such a sequence starts with long lasting (mean ± st.dev.: 15 ± 8 s) monotonous repetitions of short echemes (SE) of 23 ± 7 ms duration (segment A, Fig. 7 – for statistic parameters see Table 1). After this first part of a song the first long echeme (LE) appears without interruption. Herewith ends segment A and starts segment B, which consists of 10 ± 5 phrases with a series of SE (SE duration 21 ± 7 ms) preceding LE (LE duration 251 ± 97 ms) (Fig. 8). The number of SE preceding each LE in a phrase is variable (3 to 24 with average value of 7 ± 3). The duration of segment B is 16 ± 9 s and intervals between phrases following LE are 410 ± 141 ms with the exception of the last one, which is twice as long (Table 1). The third, final segment (C) of a song, lasting 14 ± 8 s, comprises just repetitions of single LE (365 ± 90 ms) or LE preceded by 1 or 2 SE (26 ± 10 ms), while phrases are separated by intervals of 1.1 ± 0.4 s (segment C, Fig. 9). After a longer pause, during which calling males often change place and fly a few meters away, the whole song sequence starts again.

The criterion for discrimination between song phrases in the segments B and C is the sudden change in the number of SE preceding LE, which is in phrases of segment C zero to at most 2. This criterion, which of course was chosen arbitrarily, is based on the stepwise change of the song pattern mainly the number of SE preceding LE as shown in Fig. 11, and intervals between phrases (Table 1).

Sometimes, mainly if the singing male is bothered by another male in the vicinity, the regularity of this sequence (ABC) of song phrases may be somewhat disturbed, e.g. ABCBC or ABABC. Nevertheless, the regular pattern ABC prevails in most cases.

The song pattern: Frequency range

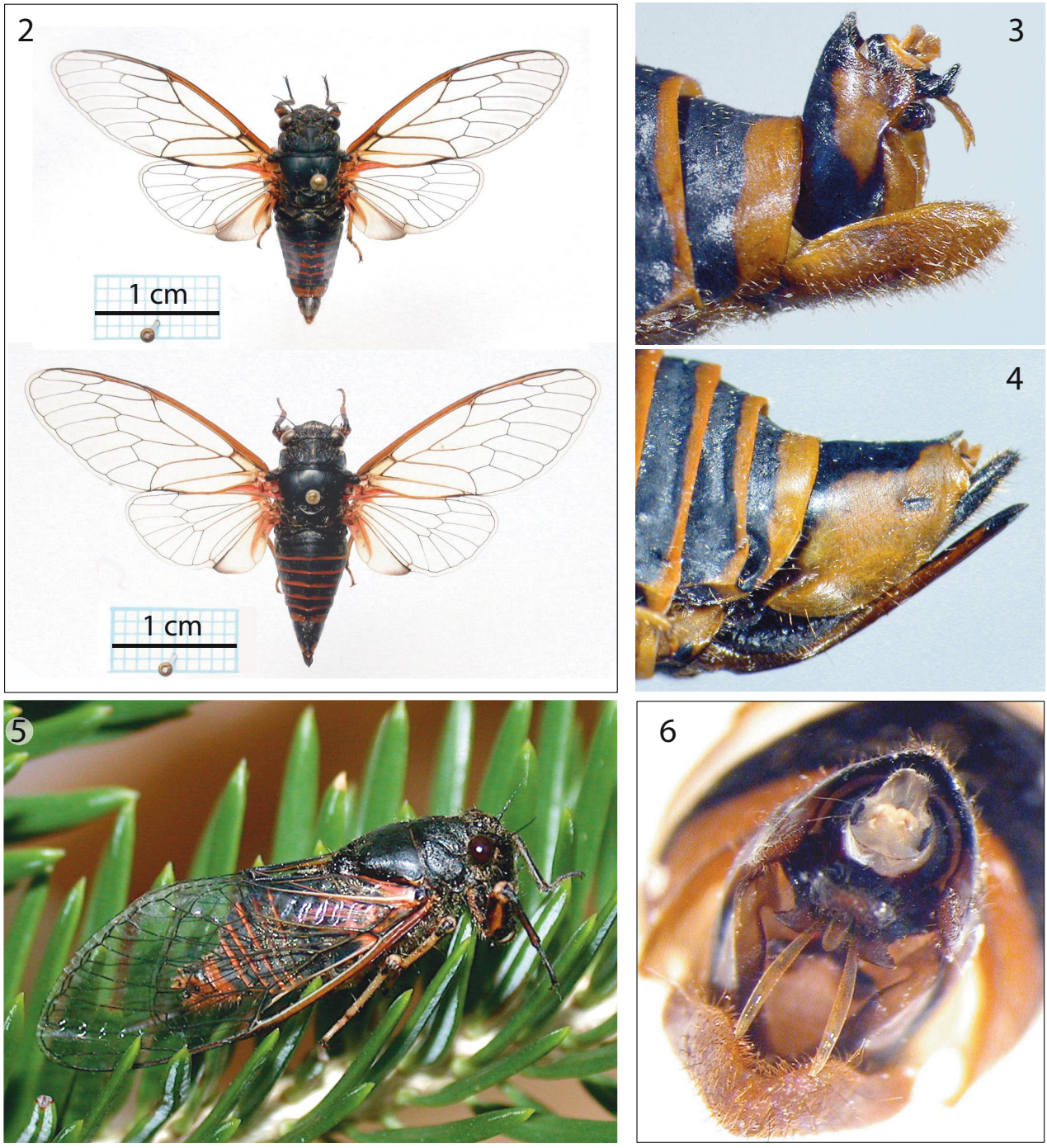
The frequency spectrum of the calling song shows broad maximum of intensity between 12 and 16.5 kHz (Figs 7–10). The –20 dB range covers the frequencies between 10 and 19 kHz.

Comparison of songs of *Cicadetta hannekeae* sp. n. and *Cicadetta macedonica*

From all the song patterns of *C. montana* complex species known till now is the song of *C. hannekeae* sp. n. the closest to the song of *C. macedonica* (Gogala & Trilar 1999). The most evident common characteristic of the songs of both species are song phrases composed by a series of SE with single LE at the end. The second common acoustic property is the presence of more segments in the song. The first segment is in both species a simple sequence of SE. The presence of such long sequences of SE has been mentioned also in Gogala & Trilar (1999) in a description of the song of *C. macedonica*, but has not been defined as a separate part of a song. The second segment comprises phrases with shorter series of SE followed by one LE and a longer pause following it.

However, the number of SE in a phrase as well as the duration of LE are different in the two species (Figs 8, 13, 14, 15). In *C. hannekeae* sp. n. the number of SE in the phrases of the segment B of the song is much lower (7 ± 3) than in *C. macedonica* (31 ± 14) and the duration of LE substantially longer (*C.h.*: 251 ± 97 ms, *C. m.*: 198 ± 53 ms) (Figs 8, 13, 14, 15 and Tables 1 and 2).

The main difference between songs of the two species is the presence of a third segment (C), occuring only in the song of *C. hannekeae* sp. n. and comprising a sequence of phrases with LE only, or LE preceded by



Figures 2–6. Morphology of *Cicadetta hannekeae* sp. n.: **2.** Habitus of a male (above) and a female (below); **3.** Male genital capsule; **4.** Female terminalia; **5.** Live male sitting on the branch of *Abies cephalonica*; **6.** View of the male genital capsule rostrad, aedeagus with pseudoparamers, uncus and claspers can be seen, in the background also a dark basal plate (unsharp).

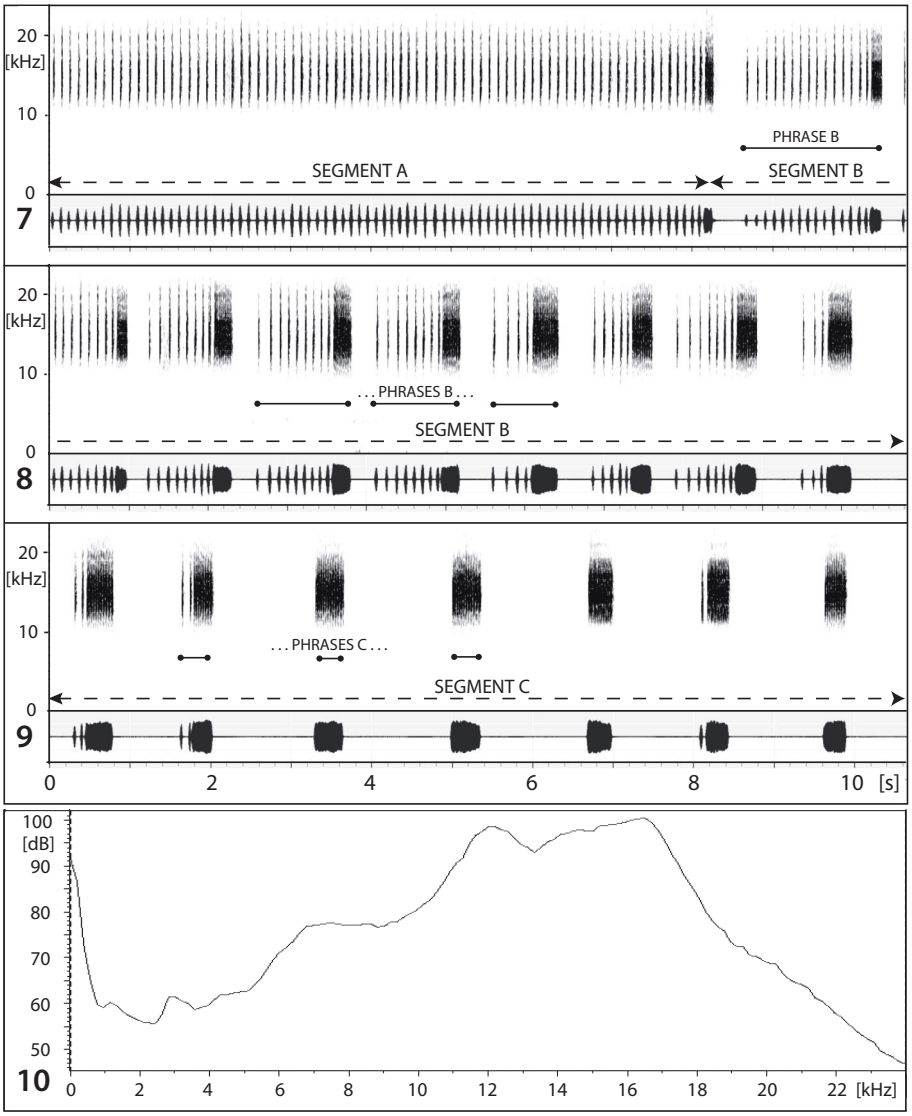
1 or 2 SE. In *C. macedonica* on the other hand, we never recorded or heard such a part of the song.

Morphology

Cicadetta hannekeae sp. n. (Figs 2 and 5) looks very similar to the closely related *C. montana* s. str. (Scopoli, 1772) or other sister species of this group, especially *C. macedonica* (Schedl, 1999).

The body length from the head to the tip of abdomen is in males 17.9 ± 0.6 mm ($N = 18$), while in 3 females the average body length was 19.2 mm (18.3–20); the tegmina in males measure in length 19.3 ± 0.6 ($N = 17 * 2 + 1$) mm and in width 7.6 ± 0.3 mm; in the females the average tegmina length was 20.9 (20.6–21.3) and the width 8.4 mm (8.2–8.8).

The overall coloration is black with yellow and reddish brown markings (Figs 2 and 5).



Figures 7–10. Oscillograms, spectrograms and frequency spectrum of the typical calling song of *Cicadetta hannekeae* sp. n.: **7.** Segment A with the beginning of a segment B (oscillogram – below, spectrogram – above); **8.** Segment B, **9.** Segment C; **10.** Frequency spectrum of one LE echeme from segment B. In Figures 7–9 it is also shown, what we understand as phrases B and C.

Males. The head is black, with a yellow patch on the epicranial suture. Postclypeus laterally yellow, rostrum reaching the tip of middle coxae. Pronotum black, front and hind edge with thin yellow or light brown rim laterally, pronotal collar in some specimens (2 out of 11 males) with two light brown patches in the middle. Lateral angles of pronotal collar pronounced. Scutum and cruciform elevation black, only basilaterally and posteriorly near the wing groove brown. Abdominal tergum 1 in front of tymbals with brown markings, tymbal with 2 long and 2 short ribs. Terga 3 through 7 black with broad reddish brown borders. Pygophor as shown in Figs 3 and 6 with pronounced dorsal beak and short pointed upper lobes of pygophor. Median lobe of uncus pronounced and black, claspers flat and dark brown, pseudoparamers long and flattened, with sharp point. Basal plate of aedeagus broad Y-shaped (Fig. 6). Basal lobes touching the main capsule (Fig. 3).

Ventral side black with yellow to reddish brown markings. Front femora with three spines. Opercula basally dark, distally yellow, broadly rounded, not overlapping, with a short yellow spine. Abdominal sternites medially dark, distal edges broadly reddish brown, episterna dark with distal edges reddish brown.

Tegmina and hind wings transparent with a slight golden-brown hue, without markings, with exception of clearly coloured basal parts. Basal cells of first wings yellow, basal membrane reddish as well as the base of the costal cell of hind wings. Veins with characteristic colours. Costal vein brown. Median and anterior cubitus vein with short common root, shorter than arcus, dark brown or black, sometimes arcus partly whitish. Subcosta plus radius whitish, inner rim toward a radial or discal cell dark. Medial and cubitus anterior veins till nodal line or even till crossveins whitish. Distal veins on tegmina and on hind wings dark. Cubitus pos-

Table 1. Temporal parameters of the song of *C. hannekeae.* 13 recordings of segment A, 16 recordings of segment B and 18 recordings of segment C were evaluated. S = song segment, SE dur = short echeme duration, SE rate = short echeme rate, A dur = duration of segment A, N(SE)/fr = number of SE in a phrase, LE dur = duration of long echemes, IntrvLE-SE = interval between LE and following SE, ILE-SElast = interval between a last LE in a segment B and the following SE, B dur = duration of segment B, LE rate = rate of LE repetitions, Interval/fr = interval between phrases C, C dur = duration of segment C.

S	Parameter	count	unit	mean	st.dev.	median	1. QT	3. QT	MIN	MAX
A	SE dur	953	ms	23.4	7.3	23	19	25	7	60
	SE rate	939	N(SE)/s	8.3	1.7	8.3	7.7	9.4	0.1	14.9
	A dur	13	s	14.6	8.2	15	7	20.4	2.1	30.3
B	SE dur	1619	ms	21.4	7.1	19	18	24	3	93
	SE rate	1380	N(SE)/s	9.0	1.9	9.1	7.9	10.2	0.4	18.9
	N(SE)/fr	187	N	7	3	6	4	8	3	24
	LE dur	255	ms	251	97	227	183	310	31	526
	ItrvLE-SE	224	ms	410	141	394	322	459	153	1074
	ILE-SElast	24	ms	943	359	972	704	1100	294	1860
	B dur	26	s	16.0	9.1	14.4	8.6	21.8	2.6	34.5
C	SE dur	118	ms	26	9.6	23	20	30	10	63
	LE dur	213	ms	365	90	354	312	427	126	606
	LE rate	204	N(LE)/s	0.82	0.95	0.69	0.58	0.82	0.04	4.50
	Interval/fr	190	ms	1129	392	1086	860	1368	315	2562
	C dur	25	s	13.7	8.2	13.4	7.1	18.0	0.5	36.1

terior vein plus first anal vein at claval fold of tegmina yellowish brown. Veins of hind wings dark with exception of median vein. Veins of the anal lobe of hind wings with broad reddish brown frame.

The number of apical cells on front wings is 8 and on hind wings 6 but in some specimens on one side there may be also 7 (1 specimen out of 17) or 9 (2 out of 17) apical cells on front wing and on hind wing 7 (1 out of 17).

Female. Differences from males are in the size of the body and in coloration (Figs 2 and 4). Pronotum with yellow median line and two small yellow patches in the median part of the collar. Scutum has yellow coloration also along parapsidal suturae, at frontal and caudal ends. Also tegminal veins M have whitish coloration extended towards apical cells. The form and coloration of female terminalia are clearly shown in Figure 4.

Geographic distribution

Cicadetta hannekeae sp. n. is distributed in the Southern Balkans (Fig. 1). It is allopatric with *C. macedonica* and the border between populations of the two species seems to be, at least in Greece, around the 40° N latitude. *Cicadetta macedonica* was found on North Pindos near Pentalofos (1700 m), on Mt. Vourinos near Siatista (1200–1400 m) and on Mt. Pelister (1200 m) and other localities cited by Gogala *et al*. 2005 (Mt. Galičica, Ra-

Table 2. Temporal parameters of the song of *C. macedonica.* 7 recordings of segment A and 9 recordings of segment B were evaluated. S = song segment, SE dur = short echeme duration, SE rate = short echeme rate, A dur = duration of segment A, N(SE)/fr = number of SE in a phrase, LE dur = duration of long echemes, IntrvLE-SE = interval between LE and following SE, IntrvSE-LE = interval between a last SE in a phrase and the following LE, B dur = duration of segment B.

S	Parameter	count	unit	mean	st.dev.	median	1. QT	3. QT	MIN	MAX
A	SE dur	747	ms	30.0	6.5	31	24	35	4	48
	SE rate	739	N(SE)/s	9.5	1.2	9.3	9.0	10.3	4	48
	A dur	6	s	12.7	8.0	10.7	7.5	13.6	6.2	27.8
B	SE dur	1888	ms	28.6	6.7	29	23	33	4	50
	SE rate	1823	N(SE)/s	10.4	2.0	10.5	9.1	11.8	0.1	20.8
	N(SE)/fr	64	N	31	14	28	19	39	13	76
	LE dur	56	ms	198	53	215	151	240	96	296
	IntrvLE-SE	62	ms	475	150	451	394	557	221	1111
	IntrvSE-LE	64	ms	21.2	9.1	21	15	28	4	42
	B dur	8	s	22.3	7.8	21.4	16.9	24.4	14.3	39.0

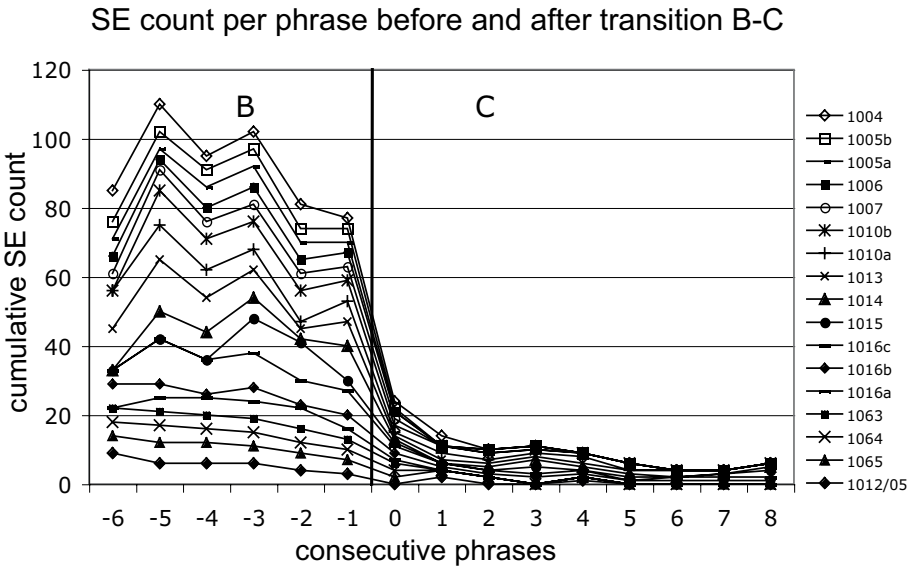


Figure 11. Graph showing the stepwise change of the short echeme (SE) count per phrase supporting the distinction between B and C segment of the calling song (N = 17, legend shows the names of the recording files). A criterion for the choice of a "0" phrase beginning the segment C was the first phrase in a song with less then 2 short echemes preceeding a long echeme (LE). A cumulative SE counts in 6 preceeding phrases and in up to 8 phrases following the "0" phrase (1st phrase of the segment C) are shown.

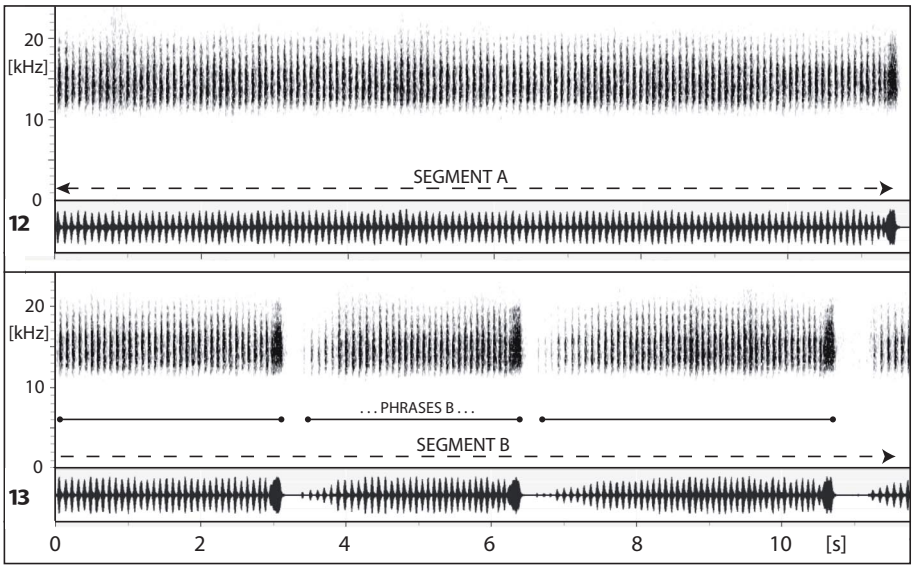
dika Gorge and Suva Planina). The most northern localities of *C. hannekeae* sp. n. are on the Katara Pass near Metsovo, on the mountains above Moucha (1100–1250 m), above the southeastern coast of Lake Plastiras, and on Mt. Othris (1250 m).

Ecology

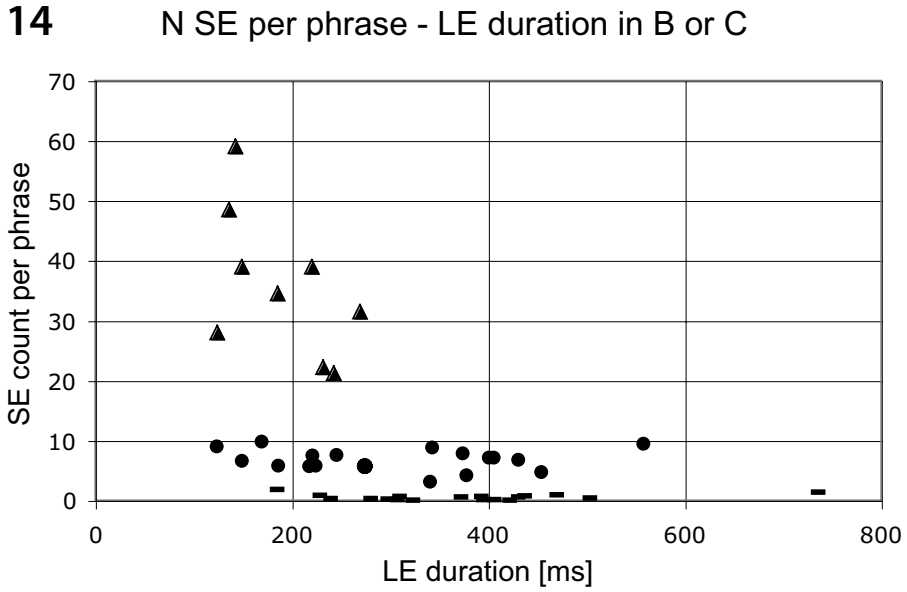
Cicadetta hannekeae sp. n. is found in the mountains at elevations between 800 and 1700 m. The males often stay and sing on Greek Fir (*Abies cephalonica* Loudon) and some other trees, but they also visit meadows or forest clearings (Fig. 16) where they sit and call for some time on grasses, ferns or other low vegetation. *Cicadetta hannekeae* sp. n. is active at daytime and sings at temperatures from as low as 16 °C to higher than 30 °C. Observation of cicadas singing on the ground was not repeated.

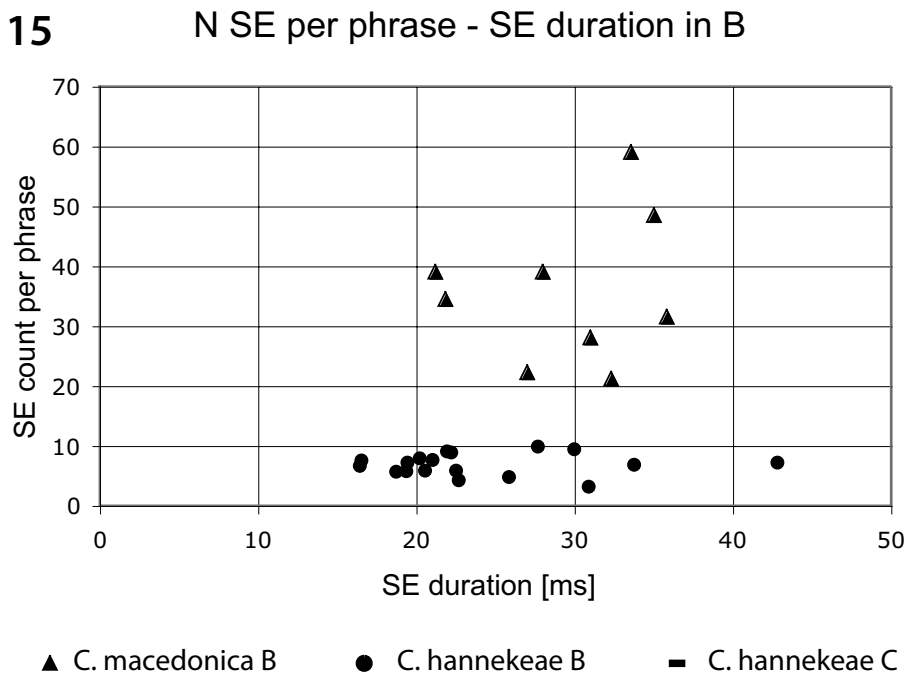
Type material examined

All specimens were collected in Greece. One specimen from Mt. Parnassos (not listed as paratype) was kept in absolute alcohol for molecular analysis.



Figures 12–13. Oscillograms (below) and spectrograms (above) of the typical calling song of *Cicadetta macedonica*: **12.** Segment A with the first long echeme ending the segment A; **13.** Selection of the segment B with three phrases B. Segment C does not exist in this species.





Figures 14–15. Graphs showing differences between selected parameters of the songs of *Cicadetta hannekeae* sp. n. and *Cicadetta macedonica*. Average values of 9 recordings of *C. macedonica* (triangles – segment B) and 18 recordings of *C. hannekeae* (filled circles for segment B and and dashes for segment C) are included. **14.** SE count per phrase in B (and where applicable C segments) against LE duration of both species; **15.** SE count per phrase against SE duration in B segments of both species.

Holotype male. (1) Mt. Parnassos (∼1500 m), 07.06.2005.

Paratype females. (1) Fokida, Panourgias, junc. to Pyra, (∼1200 m) 08.06.2005; (2) South Pindos, Moucha (1100 m) 30.06.2006.

Paratype males. (1) Mt. Parnassos (∼ 1500 m), 03.06.1995; (3) Mt. Parnassos (∼1500 m), 07.06.2005; (1) Fokida, Eptalophos, ∼ 950 m, 07.06.2005; (1) Fokida, Panourgias, junc. to Pyra, (∼1200 m) 08.06.2005; (5) Peloponnese, Mt. Parnon, (∼1700 m), 11.06.2005; (2) South Pindos, Moucha (1100 m) 30.06.2006; (1) Katara Pass above Metsovo (1300 m) 03.07.2006.

Additional material from Mt. Chelmos and Panachaikon is not designated as paratypes because these localities were not acoustically investigated. As they are morphologically indistinguishable and originate from the Peloponnesus where we never found any other species of *C. montana* complex, we used them for evaluation of morphological characters (see Table 1).

Labels carry the following data. Hellas (Pelopon.: Achaia) Oros Panachaikon, Zastova-Psarthri 1000–1650 m, 16. VII. 1974 F. Willemse c.s.; (1) Greece 12.06.97 Ahaia, (Mt.) Chelmos 1700 m, N 38°01′36″ E 22°13′24″ Leg J. Dils; (4) Chelmos Mt, 1900 m, 21–23 June 2006, Greece, leg. S. Davkov.

Etymology

We devote this species to Hanneke Drosopoulou, who supported our entomological work in many ways.

Figure 16. Habitat of *Cicadetta hannekeae* sp. n. on the slope of Mt. Parnassus, where this species has been found for the first time.

Discussion

In our paper it is shown again that in *Cicadetta montana* complex the song pattern or song parameters offer the best characters for recognition and determination of a single species (Puissant & Boulard 2000; Gogala & Trilar 2004; Sueur & Puissant 2007a, b). By comparing *C. hannekeae* sp. n. to the other species of this complex described so far it is evident that *C. macedonica* is the closely related one, not only according to its geographical distribution but also to its song pattern (Gogala & Trilar 1999, 2004). Yet, even when listening to individuals of the two species (with an ultrasonic detector) one can easily recognize and distinguish them without any analysing tools.

A recent paper of Sueur & Puissant (2007b) shows that in Western and Central Europe exists another pair of closely related species of *C. montana* complex with close but not identical sound emissions: *C. cerdaniensis* Puissant & Boulard 2000 in the South and *C. cantilatrix* Sueur & Puissant 2007 in Central Europe.

Preliminary results of DNA analysis of the acoustically proven material in the laboratories of Chris Simon (University of Storrs, Connecticut, USA – personal communication) support our distinction of *C. hannekeae* sp. n. towards other species of *C. montana* complex. This analysis also supports distinction between *C. cerdaniensis* and *C. cantilatrix*.

It is an interesting fact, that quite a number of cicadas in the southern Balkans have songs with sequences comprising fast repetitions of short echemes in combination with longer echemes, *e.g. Cicadetta flaveola* (Brullé, 1832) (Gogala & Drosopoulos 2006), *C. macedonica* (Gogala & Trilar 1999, this paper), *Cicadetta carayoni* Boulard, 1982 (Gogala & Trilar, unpublished data). Is this connected with high environmental temperature or other environmental factors in S.E. Europe? The only species of related cicadas emitting a similar song pattern is *Cicadetta podolica* Eichwald, 1830 (Trilar & Gogala 2007).

An interesting observation is that we found *C. macedonica* usually together with *C. montana* s. str. (*e.g.* Fig. 1 sites 12, 13 and 15) and in some localities together with *C. montana* s. str., *C. cantilatrix* and also with *C.* cf. *podolica* (Fig. 1 site 17). In contrast to this, we did not find other congeneric species of *C. montana* complex together with *C. hannekeae.*

Clearly, we have here a case of allopatric distribution, but the reason for this is difficult to explain at this stage. Nevertheless, there are other cases of transitions from one species to the other close related one at approximately the same latitude in Greece. Such a case are grasshoppers *Stenobothrus rubicundulus* Kruseman & Jeekel, 1967 and his southern substitute *St. clavatus* Willemse, 1979 with a hybrid zone on Mt. Tomaros near Ioanina (Norbert Elsner, personal communication) and also some other pairs of species of Orthoptera (Willemse 1984, 1985a, 1985b). Also the geographic distribution of some other "Auchenorrhyncha" species complexes in Greece have a similar pattern (*e.g. Muellerianella* species complex; Drosopoulos 1983).

Conclusively, the need of various methods and studies in separating species complexes in several taxa, is emphasized by this paper. Thus, bioacoustic studies were again the most powerful "tool" in clearing the species of *C. montana* complex, while for separation in *Muellerianella* for example cytogenetics and food-plant specificity are most useful.

Acknowledgements

We are grateful to Andrej Gogala (Slovenian Museum of Natural History, Ljubljana), who did all the preparations of material. Hanneke Drosopoulou supported through years in many ways our investigations. We are very grateful to obtain additional specimens of mountain cicadas from the Peloponnesus by Hans Duffels, Amsterdam and David Emery, Sydney. For many important advices and discussions we are grateful to colleagues and friends Hans Duffels (Zoological Museum Amsterdam), Norbert Elsner (Universität Göttingen) and Katica Drobne (Scientific resarch center of SASA, Ljubljana). We appreciate also the financial support to one of us (MG) by the Slovenian Academy of Sciences and Arts. The research of one of us (TT) was part of the programme "Communities, relations and communications in the ecosystems" (No. P1-0255) finaced by Ministry of Higher Education, Science and Technology of the Republic of Slovenia. Travelling expenses were partly covered by the Agricultural University of Athens to the second author. We are grateful for useful suggestions to the reviewer Jérôme Sueur (Muséum national d'Histoire naturelle, Paris).

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