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CICADIVETTA GOUMENISSA, A NEW CICADA SPECIES FROM PELOPONESOS, GREECE (HEMIPTERA: CICADIDAE)

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Abstract – Near the village of Goumenissa, Peloponesos, Greece, we heard and recorded an unusual and unknown cicada song in the years 2005 and 2006. It was high pitched, hardly audible to humans and therefore we had to use ultrasonic detectors. Later we collected some specimens and found out that it is an undescribed species. Here we publish a description of this new taxon with the name *Cicadivetta goumenissa* sp. n. In addition to morphological characteristics this species is distinguished by a song pattern with very fast sequences of short echemes (SE, duration 26±7 ms) of different duration (a few SE up to more than 500 and 37 s duration and repetition frequency of 13-22 SE/s), followed by single long echemes (LE, duration: 535±88 ms). Exceptionally there are sequences with longer LE echemes (760±284 ms) and without or just a few SE in-between.

KEY WORDS: Hemiptera, Cicadidae, new species, songs, singing cicadas

Izvleček – *CICADIVETTA GOUMENISSA*, NOVA VRSTA ŠKRŽADA S PELOPONEZA, GRČIJA (HEMIPTERA: CICADIDAE)

Na Peloponezu pri kraju Goumenissa v Grčiji smo v letih 2005 in 2006 slišali in posneli nenavaden in neznan napev škržada. Pri tem smo uporabljali ultrazvočne detektorje, saj je frekvenčno območje teh signalov na zgornji meji človeku slišnega območja. Kasneje smo nekaj teh majhnih škržadov tudi ujeli in ugotovili, da gre za novo, še neopisano vrsto. To novo vrsto imenujemo *Cicadivetta goumenissa* sp. n. Poleg morfoloških značilnosti je za to vrsto značilen napev s hitrim sosledjem kratkih ehemov

(SE, trajanje 26±7 ms) z nekaj SE do več kot 500 SE v frazi s ponavljalno frekvenco 13-22 SE/s , ki ga prekinjajo daljši ehemi (LE, trajanje 535±88 ms). Izjemoma so v napevu tudi sekvence z daljšimi LE (760±284 ms) in z le nekaj SE med njimi ali celo brez njih.

KLJUČNE BESEDE: Hemiptera, Cicadidae, nova vrsta, petje, pojoči škržadi

Introduction

Greece is certainly one of the Mediterranean hotspots for insects and also for cicadas. The use of bioacoustic methods in field investigations enabled cicadologists during last years to become much more efficient in searching for new taxa than before (e.g. Gogala & Trilar 2004, Gogala et al. 2009, 2011, Hertach 2011, Puissant & Sueur 2010).

Many new species of Cicadidae: Tibicininae (sensu Moulds 2005) were discovered and described also in Europe due to this new bioacoustic approach (Gogala & Trilar 1999, 2004; Gogala et al. 2008, 2009, 2011; Hertach 2011; Puissant & Boulard 2000; Sueur & Puissant 2007a, 2007b; Puissant & Sueur 2010).

During the years 2005-06 on Peloponesos, Greece, we acoustically detected a cicada song with very fast repetition of short echemes, different from anything that we heard or recorded till then. We also succeeded to collect some specimens, so that a comparison with hitherto known species of similar morphology was possible. Here we are describing the morphology and bioacoustic characteristics of this new taxon.

Materials and methods

We made field trips to Peloponesos in the years 2004-2006 and in 2010. Only on 9. 6. 2005 and 28. 6. 2006 we heard, recorded and collected this new species. It was present just at one locality, around the village Goumenissa near Vrissari (38°02.802' N and 22°01.297' E) at about 720 m above sea level.

For the names and spelling of localities we follow the local inscriptions and transliterations used in the maps of the "Road Editions", Nr. 4, Athens (1996).

For acoustic detection and recording of songs we used ultrasonic detectors Pettersson D-200 with electret microphones of the same producer, mounted in front of a Telinga reflector (57 cm diameter) and connected to the solid state recorders Marantz PMD-660 and PMD-670. Due to high frequency range, without ultrasonic detectors we would not be able to hear the acoustic signals of this cicada species. For sound analyses we used Raven 1.4 (Cornell Lab of Ornithology), Amadeus Pro 2.0 (HairerSoft) and Seewave package (Sueur et al. 2008) as a part of R software platform (R Development Core Team 2008). We first localized cicadas acoustically and then collected them with an entomological net.

Morphological investigations were made on dry prepared specimens. For morphological terminology we follow Moulds (2005). The type material is deposited in the collection of the Slovenian Museum of Natural History (PMSL). Song recordings

are deposited in the Slovenian Wildlife Sound Archive of the same museum. A sample of selected recording is available on the web pages *Songs of European singing cicadas* <http://www.cicadasong.eu>.

Results

***Cicadivetta goumenissa* Gogala, Drosopoulos & Trilar sp. n.**

Two of us (MG and SD) first heard and recorded the typical song pattern of this species from the road in the village of Goumenissa on 9. 6. 2005. Later we found better and less noisy locality a few hundred meters to the south. It is situated at and above the deviation to Goumenissa and Vrissari from the main road leading from Patra and Chalandritsa to Kalavrita. There we made good recordings of the song and collected a few specimens. Next year all three of us detected and later collected this species at the same locality on 28. 6. 2006.

Song pattern.

The pattern of the calling song is composed of very fast repetition of short echemes (SE), occasionally interrupted by longer echemes (LE – long echeme) (Figs. 1, 2A). The average duration of SE is 26±7 ms and the LE 535±88 ms. In some recordings there are exceptionally long echemes without SE or with only 1 to 3 SE in-between. In such parts of the song the duration of LE is longer, up to 1.8 s (760±284 ms), also short echemes between LE are longer (43±16 ms, Fig. 2B), but this pattern changes

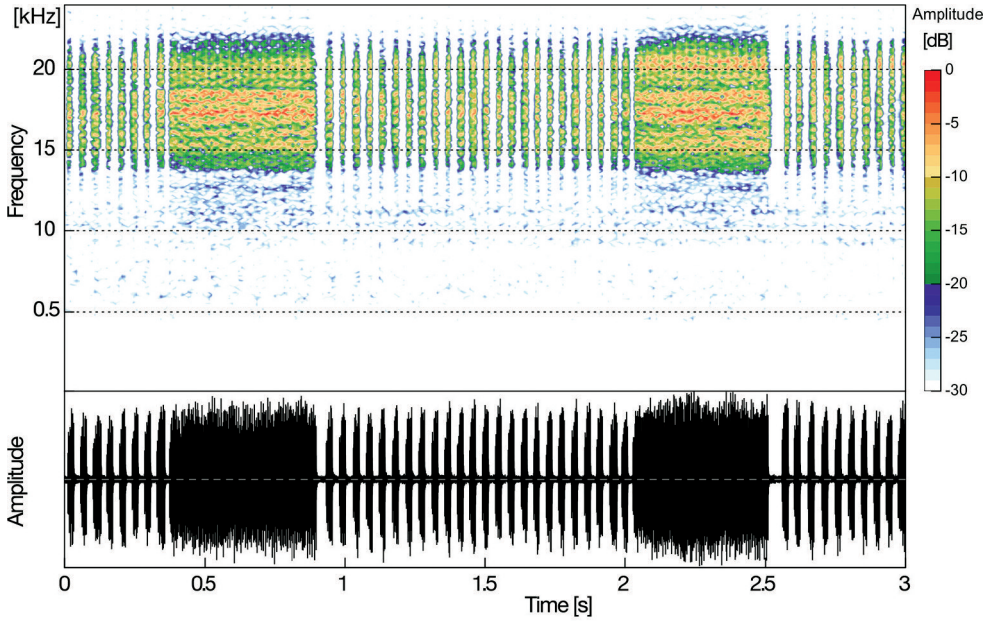

Fig. 1: Sonagram and oscillogram (below) of the song selection of *Cicadivetta goumenissa* sp. n.

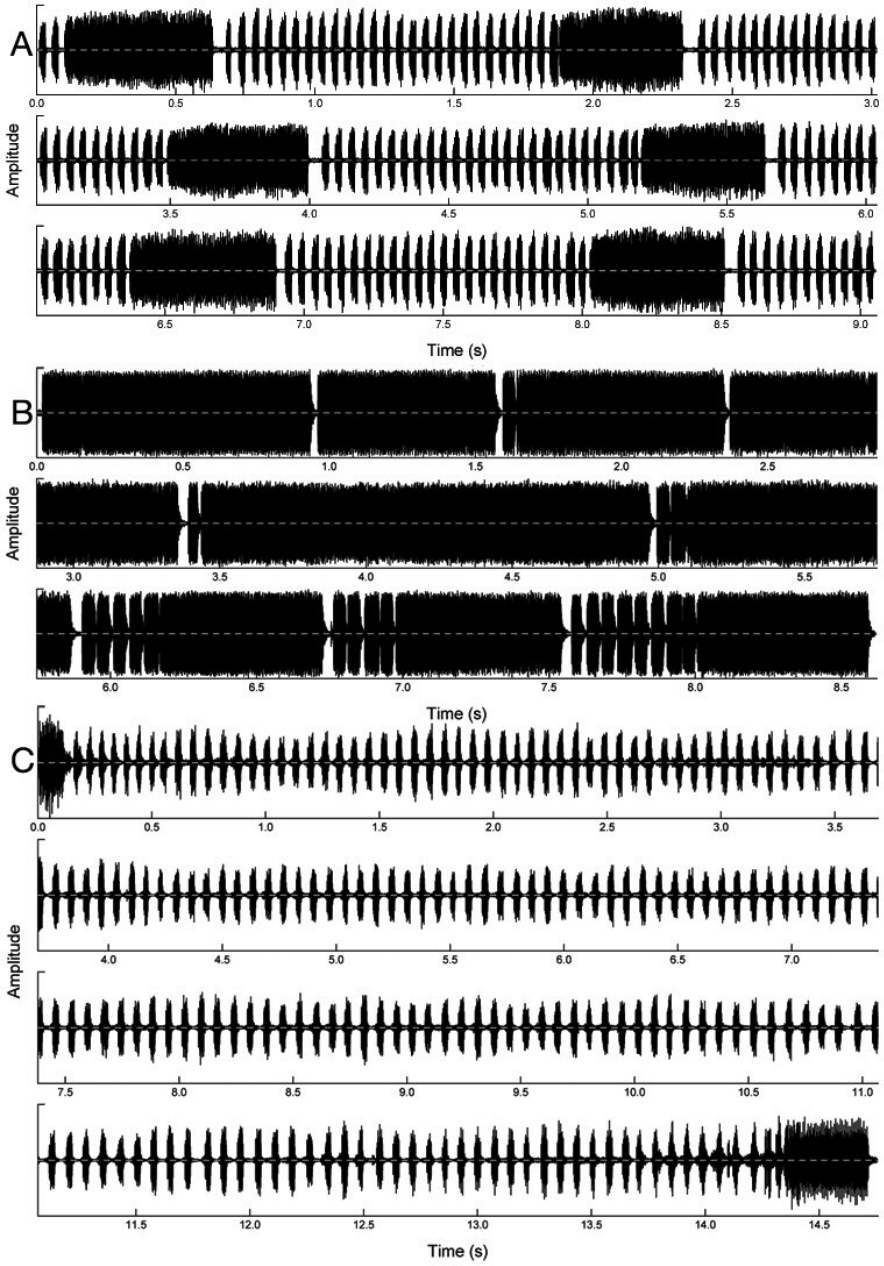

Fig. 2: Oscillograms of three song selections of the *Cicadivetta goumenissa* sp. n. A – a typical selection of the "normal" song; B – rare type of song with just a few or without SE between longer LE; C – other extreme song pattern with a very long sequence of SE.

without interruption, continuously to a more frequent pattern of about 10 to 50 SE in a sequence, followed by one LE (Figs. 1, 2A). In the similar way such "normal" phrases can slowly extend to a very long sequences of SE, mentioned above ending or not with one long echeme (Fig. 2C). Due to such unusual behaviour we can not speak of various types of songs, because the pattern of phrases can continuously vary from one extreme to another. The repetition rate of SE is very high, between 13–22 SE/s with a mean ± standard deviation 18.4±1.9 SE/s.

It is unusual, that a number of SE in a single song varies in such a wide range and does not allow us to describe different types of the song. Therefore a comprehensive statistical analysis of the phrase length or number of SE in a phrase does not have much sense. We present here just a few examples of shortest, longest and most frequent medium long phrases (Fig. 2) and basic statistical values. The same animal can during one uninterrupted song vary this parameter without any regularity.

The single SE comprises four-click units, usually 2, 3 and sometimes up to 5 or more subsequent units. Therefore the duration of SE depends on the duration of these minimal constituents. Such phenomenon has been described also in a related species *Cicadivetta flaveola* (Brullé 1832) and *Cicadivetta carayoni* (Boulard 1982) with similar short echemes in a song (Gogala & Drosopoulos 2006, Trilar & Gogala 2010).

Carrier frequency of the calling song is very high with a maximum at 17.5±0.8 kHz and the -20 dB range 13.6±0.6 - 22.9±0.7 kHz (Fig. 1).

Morphology

We collected altogether 4 males and one female.

Specimens examined. **Holotype** ♂: HC05-014 - Greece: Peloponesos, Goumenissa, Vrissari, 38°02.802' N and 22°01.297' E, 9. 6. 2005, leg. M. Gogala, S. Drosopoulos.

Paratypes ♂: HC05-013 - Greece: Peloponesos, Goumenissa, Vrissari, 38°02.802' N and 22°01.297' E, 9. 6. 2005, leg. M. Gogala, S. Drosopoulos; HC06-030 – ibidem, 28. 6. 2006, leg. M. Gogala, S. Drosopoulos, T. Trilar; HC06-031 – ibidem, 28. 6. 2006, leg. M. Gogala, S. Drosopoulos, T. Trilar. **Paratype** ♀: HC-032 – ibidem, 28. 6. 2006 leg. M. Gogala, S. Drosopoulos, T. Trilar.

Description.

Dimensions: The body length from the head to the tip of the abdomen of males is in average 13 (12.4-13.8) mm (12.4, 12.6, 13.2, 13.8) and of the single female is 14.5 mm.

The overall coloration is black with yellow, orange-red and brown markings (Figs. 3, 4, 8-10, 12).

The **head** is black, supra-antennal plate yellow, in some specimens is tip of postclypeus with small yellow patch and another also in the middle of frontoclypeal suture. Postclypeus laterally yellow, rostrum reaching the tip of middle coxae (Fig. 12).

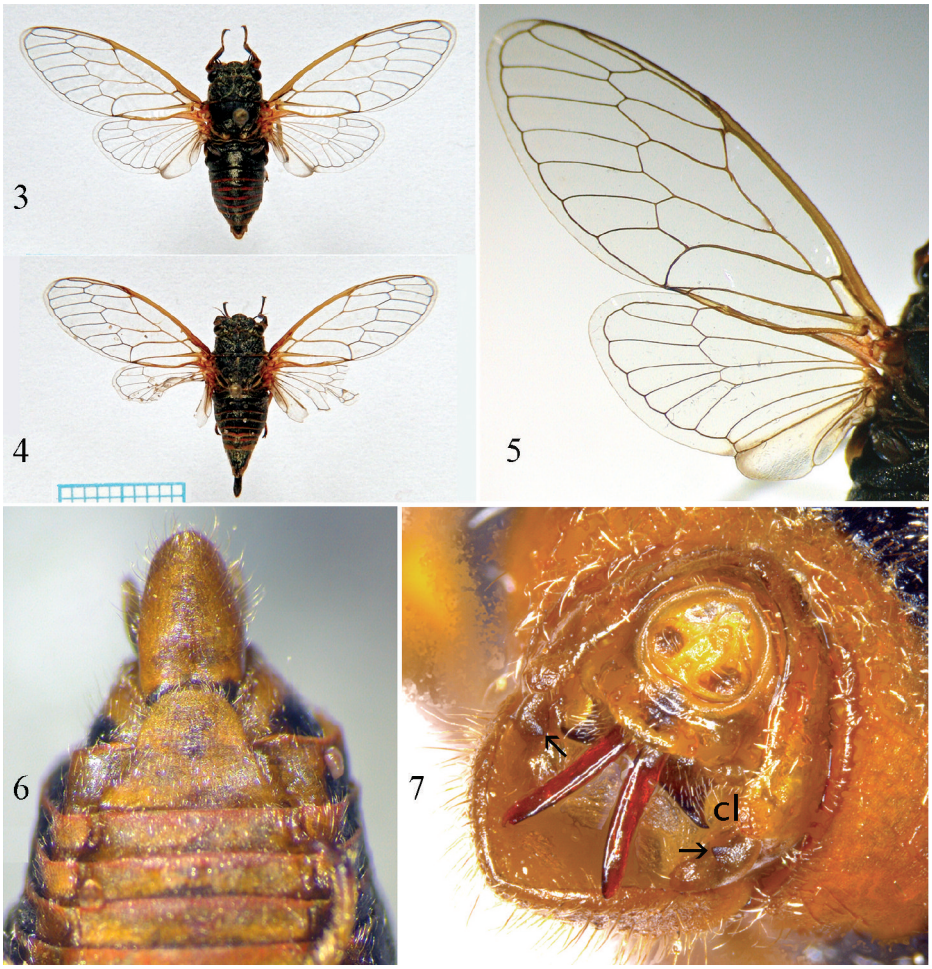

Fig. 3-7: *Cicadivetta goumenissa* sp. n. male (3) and female (4); 5 – details of the wing structure; 6 – ventrum of the male; 7 – genitalia with claspers (cl) and the inner teeth (arrows) and pseudoparamers.

Antennae proximally black, distally yellow, in one specimen last 1.5 segments black. Postclypeus black, lateral edge yellow.

Thorax: Pronotum black, with a narrow mediane yellow line distally, hind edge with light brown rim laterally. Mesonotum black, cruciform elevation (scutellum) black or brown with two yellow patches laterally, mesonotal posterior ridge near the wing groove and metanotal ridge laterally yellow. Ventral side of thorax dark, anepisternum 2, katepisternum 2 and anepimeron 2 yellow (Fig. 12).

Wings: The tegmina (fore wings) in males measure in length 15.1±0.8 mm and are 6±0.2 mm wide (N=8), while the length of the hind wings is 9.4±0.8 mm. The aver-

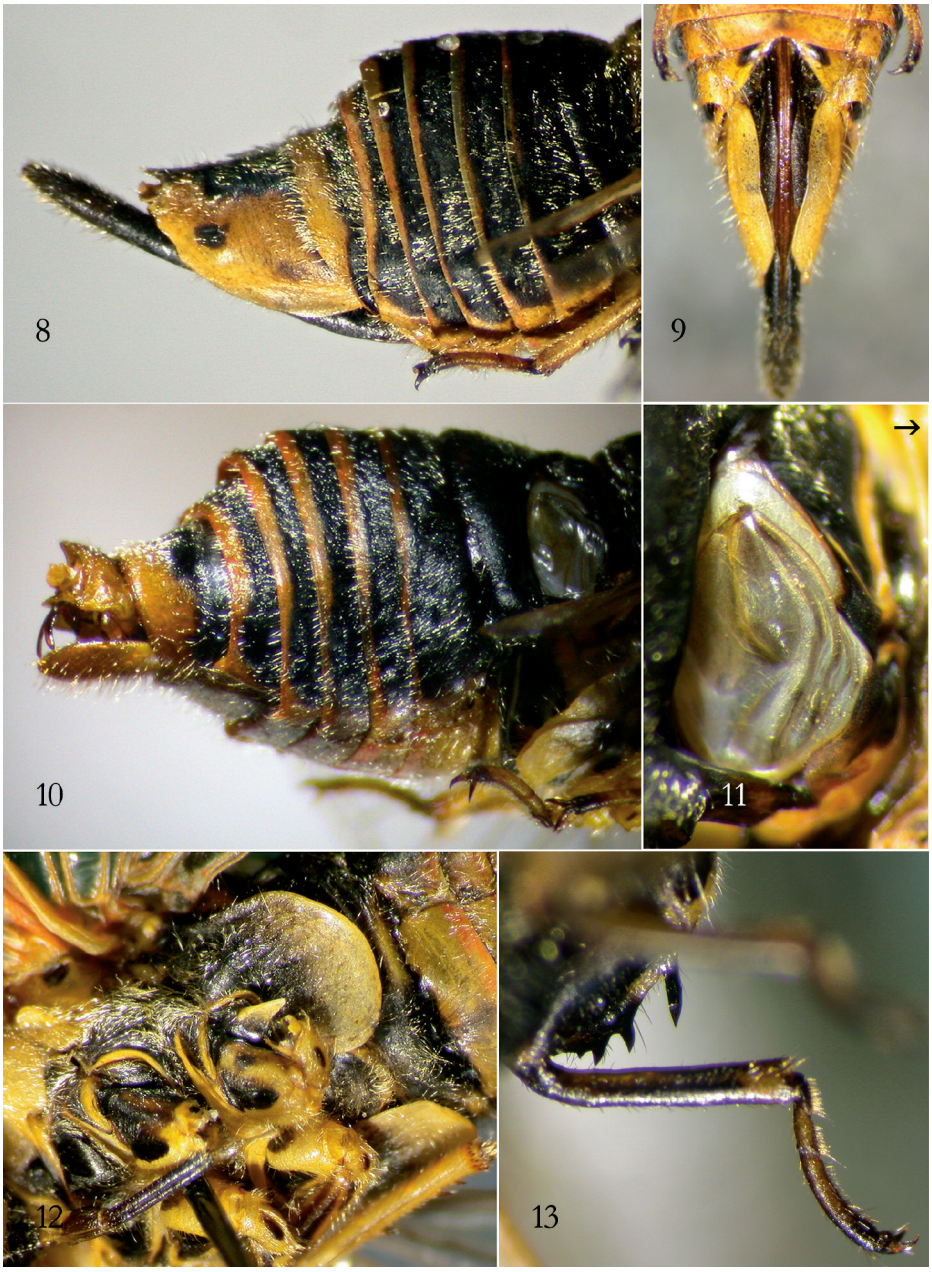

Fig. 8-13: *Cicadivetta goumenissa* sp. n. lateral view of female abdomen (8) and of male abdomen (10); 9 – ventral view of the female terminalia; 11 – right tymbal, arrow shows the frontal direction; 12 – sternum, form of operculum and meracanthus can be seen; 13 – right front leg with a big primary spine and 3 secondary spines.

age length of the female's fore wings is 14.7 mm and the width 5.9 mm (N=2). Fore and hind wings transparent, without markings, with exception of yellow-reddish basal membrane (Fig. 5). Veins proximally yellow, distal third of veins on fore and hind wings black. M and CuA of tegmina fused at the base, fused part approximately the same length as arculus. The number of apical cells on front wings is 8 and on hind wings 6. Ulnar cell 1 slightly longer than apical cell 1 (1-1.1 times in males, 1.1-1.2 times in a female) (Fig. 5).

Legs: Front femora with a big primary spine and 3 secondary spines, the last distal one small, sometimes less distinct (Fig. 13). Fore leg coxae dark, laterally yellow to brown, dorsally at the tip and below the primary spine yellow, trochanter yellow with a black patch medially. Tibiae brown, tarsi yellow, darker at the tip of the last segment (tarsomere) as well as the claws. Coxae of the mid and hind legs black, medially and distally yellow, trochanters yellow with a black patch ventrally (Fig. 12). Femora yellow with a long dark patch laterally, tibiae medially brown to yellow, proximal and distal end black. Tarsi yellow to brown, third tarsomeres distally darkened as well as the claws and parempodial setae.

Abdomen: Segments broadly triangular in cross section. Terga 3-7 black with broad reddish brown hind borders (Figs. 8, 10). Ventral side yellow, in some specimens sternites distally reddish (Figs. 9, 12).

Males: Opercula basally dark, distally yellow, broadly rounded, not overlapping, with flattened yellow spine (meracanthus) (Fig. 12).

Tymbal with a tymbal plate, 2 long and 2 short ribs (Fig. 11). Abdominal tergum 1 in front of tymbals with brown markings. In males, sternite VIII 1.04-1.22 times longer than the median length of sternite VII.

Male genitalia: Pygophor (Figs. 7, 10) with triangular dorsal beak and flat, pronounced and rounded upper lobes of pygophor. Basal lobes touching the main capsule. Basal lobus of pygofer with an inner tooth (Fig. 7). Base of aedeagus straight, pseudoparamers flattened and distally divergent, the tip rounded up (Fig. 7). Uncus small, yellow to brown, rounded. Claspers flat, hooked anterolaterad (Fig. 7).

Females: abdominal sternites in the middle with diffuse dark patches. The tergite 8 yellow, proximally black. The sternite 8 yellow with a pair of black patches basally (Fig. 9). The tergite 9 yellow with dark patch dorsally and basally and also dark spot around stigma (Fig. 8). Ovipositor very long, about 1/3 of it extending beyond the tip of the tergite 9.

Ecology. Individuals of *C. goumenissa* sp. n. were found till now only in the described locality near Goumenissa, mainly on *Quercus coccifera*, but also on other bushes and trees (Fig. 14). However, at this locality we recorded also *C. flaveola*, *Dimissalna* (=*Tettigetta*) *dimissa* (Hagen 1856), *Tettigettula pygmea* (Olivier 1790) (=*Tettigetta brullei* (Fieber 1876)), *Tibicina haematodes* (Scopoli 1768), *Cicadatra atra* Fieber 1776 and *Lyristes plebejus* (Scopoli 1763).

Fig. 14: Habitat near the village Goumenissa on Peloponesos, Greece.

We found *C. goumenissa* sp. n. only during two reported dates in June. We looked for it also later in July (16. 7. 2010) at the same spot, but without success. Therefore, it seems that *C. goumenissa* sp. n. appears earlier in the season, compared to most of other Cicadettini in Greece. In the middle of July we found at the same locality instead of this new species just high population of related *C. flaveola*.

Etymology. We named this species after the village Goumenissa, the only locality, where these cicadas were found till now.

Discussion

We compared morphology of our new species with the key to Cicadettini, published recently by Puissant and Sueur (2010). According to this paper it is evident that this species belongs to the genus *Cicadivetta* – therefore *Cicadivetta goumenissa*. The only character, which according to the same authors does not completely agree with the description of this genus is the number of the apical cells on hind wings, being 6 and not 5 (Figs. 3-5).

The closest relatives of this new species are *Cicadivetta tibialis* (Panzer 1798), *C. flaveola* (Brullé 1832), *C. carayoni* (Boulard 1982) and *C. sibilatrix* (Horvath 1901).

The song structures of the first three species are known (Boulard 1995, Gogala et al. 1996, Gogala & Drosopoulos 2006, Trilar & Gogala 2010), but the song of *C. sibilatrix* has not been described yet. The song pattern of *C. goumenissa* is closest to the song of *C. tibialis* comprising series of short echemes and single long echemes, but the repetition rate of short echemes (SE) is in the new species much higher (*C. goumenissa* 13-22 s^{-1}; *C. tibialis* 4.8 s^{-1}) and the duration of short echemes shorter (*C. goumenissa* 26±7 ms; *C. tibialis* 50 ms). LE duration is in the new species 535±88 ms and in *C. tibialis* about 300 ms (Gogala et al. 1996). The song structure of *C. flaveola* and *C. carayoni* is different and similar to each other and contain short echemes of two classes. The longer echemes of both species do not exceed 60 ms (Gogala & Drosopoulos 2006, Trilar & Gogala 2010).

Acoustic key for Cicadivetta species (for *C. sibilatrix* no acoustic data exist)

1 Calling song comprising short echemes (SE duration <100 ms) and long echemes (LE duration >200 ms) ……..2
1* Calling song comprising two categories of short echemes only (SE duration <100 ms) ……..…… 3
2 Repetition rate of short echemes lower than 10 s^{-1}, long echemes shorter than 400 ms ……***C. tibialis***
2* Repetition rate of short echemes higher than 10 s^{-1} (13-22 s^{-1}). LE duration higher than 400 ms ……***C. goumenissa***
3 Calling song comprising three phrases A (simple repetition of short echemes SSSS), B (pattern of longer (L) and shorter (S) short echemes like LSSLSSL…) and C (with a pattern LSLSL …) ……..…..... ***C. flaveola***
3* Calling song very similar to the former species but without a pattern LSLSL … . Instead of this phrase C represents a sequence of long echemes LLLL … Phrase B usually composed of short and very short echemes (S) and longer echemes (L) in a pattern LSSSLSSSL …….....…….....***C. carayoni***

Samples of the sound emissions of these species can be heard at the website <http://www.cicadasong.eu>

Differences in morphology between the new species and all other related species of the genus *Cicadivetta* are substantial and allow easy species determination. We present here a short key to make a determination of *Cicadivetta* species also by morphology practical.

Key to *Cicadivetta* species

1 Hind wings with 6 apical cells.……..2
1* Hind wings with 5 (exceptionally 6 on one side) apical cells ……..…. 3
2 Ulnar cell 1 on front wings as long as apical cell 1 …….. *C. goumenissa*

2* Ulnar cell 1 on front wings 1.4 times longer than apical cell 1. Endemic species of Crete ……*C. carayoni*

3 Ulnar cell 1 on front wings 1.9 times as long as apical cell 1. Pronotum yellow with 2 black rectangular fields laterally and a median black patch proximally ….....*C. flaveola*

3* Ulnar cell 1 on front wings 1.45–1.55 times as long as apical cell 1. ……...……. 4

4 Wing venation yellow, abdominal terga laterally broadly yellow, in the middle black, scutum black, lateral edge yellow, ventral side yellow. A North African species ……..……..... *C. sibilatrix*

4* Black, median line on pronotum yellow, wing venation black, distal edges of abdominal terga reddish brown ……..... *C. tibialis*

Another question is the local distribution of *C. goumenissa*. It is not probable that it inhabits only such a limited part of Greece. In the future one should search for the presence of this species in similar habitats earlier in the summer.

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