



**NEW SUBSPECIES *CICADETTA CONCINNA ARACHNOCEPTA*  
(HEMIPTERA: CICADIDAE) FROM MACEDONIA**

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**Abstract** – A small population of cicadas from the Republic of Macedonia, closely related to *Cicadetta concinna* Germar 1821, is described as a new subspecies, *C. c. arachnocepta*. It is distributed on the high plateau Suva Planina and around the Treska gorge in the Republic of Macedonia. We studied the morphology and bioacoustic data of this population in comparison with the typical *C. concinna* from Krzyżanowice, Poland. The useful differential parameter for this subspecies is the striking dark colouration of the wings.

**KEY WORDS:** Cicadidae, *Cicadetta concinna*, new subspecies, morphology, acoustics

**Izvešček** – NOVA PODVRSTA ŠKRŽADA *CICADETTA CONCINNA ARACHNOCEPTA* (HEMIPTERA: CICADIDAE) IZ MAKEDONIJE

Kot novo podvrsto *Cicadetta concinna arachnocepta* opisujemo majhno populacijo škržadov iz Republike Makedonije, ki je sorodna z vzhodnoevropsko vrsto *Cicadetta concinna* Germar 1821. Nova podvrsta je očitno razširjena le na visoki planoti Suva planina in nad sotesko Treske na višini nad 1100 m. Proučili smo morfološke in bioakustične značilnosti te populacije in jih primerjali z znaki tipične *C. concinna* z lokalitete Krzyżanowice na Poljskem. Značilni razlikovalni znak nove podvrste je temna obarvanost oziroma osenčenost kril (Sl. 2 – 4). Tudi v zbirkah in muzejih nismo odkrili podobnih primerkov iz drugih najdišč. Po drugih,

tudi bioakustičnih znakov, se makedonska populacija ne razlikuje bistveno od tipične *C. c. concinna*, zato smo mnenja, da gre za geografsko raso.

KLJUČNE BESEDE: Cicadidae, *Cicadetta concinna*, nova podvrsta, morfologija, akustika

## Introduction

On 4. July 2000 we just finished our field investigation on Suva Planina near the village of Nova Breznica in the Republic of Macedonia. Shortly before we returned back to Skopje one of us (MG) spotted an unusual cicada in a spider net. It was a female, similar to the *Cicadetta montana* s. lato, but with very prominent dark colouration of wings. Later we tried to find and collect these cicadas at the end of May (24.-25. 5. 2003), but without success. However, during the third visit to Macedonia and to the same locality at the time period of 6.-8. July 2003 TT and VK recorded the song and collected 10 specimens of this taxon. Additional material from the same region was collected later by S.D. Davkov and became available through J.P. Duffels by David Emery from Australia.

First we did not know to which species these specimens belong to. Later it turned out that these cicadas were most similar to *Cicadetta concinna* Germar 1821, species known from Poland, Romania, Moldavia, Ukraine, Russia and some other places in Eastern Europe - usually under the synonyms *C. podolica* (Eichwald 1830) or *C. adusta* Hagen 1856. Trilar and Gogala (2007) already described the song structure of the "*C. podolica*" from Poland. We also mentioned findings of similar cicadas from Macedonia and roughly described acoustic differences between populations from Poland and Macedonia (designated as *C. cf. podolica*) in two other papers (Gogala & Trilar 2004, Gogala, Trilar & Krpač 2005) and in a book (Gogala 2013), but we did not formally describe the Macedonian specimens as a separate taxon.

## Materials and Methods

Eleven specimens of *Cicadetta concinna* ssp. nova were collected in Macedonia, Suva Planina and two other specimens in Treska gorge in the vicinity (for details see below). The morphology of typical *Cicadetta concinna* under the name *C. podolica* was described in some details by Schedl (1986). A comparative material of typical *C. concinna* Germar 1821 was acoustically investigated in Poland, Krzyżanowice (Trilar & Gogala 2007). From this locality we also received and collected our specimens for morphological investigations.

Recordings of songs of cicadas were made in the field using TELINGA PRO III and PRO V parabolic microphones (parabola diameter 57 cm) connected to SONY DAT recorder TCD-D10 (sampling rate 48 kHz, 16-bit dynamic range). In the laboratory, DAT recordings were transferred to a POWER MACINTOSH G4. Software used for viewing, editing and analyzing the song signals was RAVEN 1.3. We also used the seewave package (Sueur et al. 2008) as a part of the R software platform (R Development Core Team 2012) to generate spectrograms.

Voucher specimens of cicadas recorded and collected by the authors are preserved in the collection of the Slovenian Museum of Natural History (PMSL) in Ljubljana. Song recordings are deposited in the Slovenian Wildlife Sound Archive of the same museum. Samples of selected recordings are available on the web pages Songs of European singing cicadas <<http://www.cicadasong.eu>>.

For morphological terminology we follow Moulds (2005).

### *Cicadetta concinna arachnocepta* ssp. n.

#### Description and differential characters

##### Morphology:

The following material was examined: Macedonia: Skopje, Nova Breznica, Suva Planina, 1100 m, 1 ♀ - collected by MG 4. 7. 2000 and 3 ♀, 7 ♂ - collected by TT and VK 6.-8. 7. 2003; Macedonia: Skopje, Treska Canyon, 1160 m, 15. 6. 2004, 1 ♂, 1 ♀ collected by S.D. Davkov.

We studied and measured our material, described here as a new subspecies from Macedonia, and for comparison also specimens from Poland: Krzyżanowice, 1 ♂, 1 ♀ 24. 6. 2006 and 2 ♂ 25. 6. 2006 collected by MG and TT, 1 ♂ 7. 7. 2004 collected by D. Swierczewski and 1 ♂ 30. 6. 1999, collected by J. Szwedo.

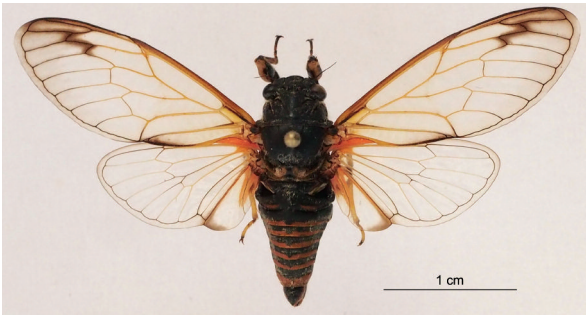
We are giving here the average values  $\pm$  standard deviation as well as minimum and maximum values between parentheses. The body size of *C. concinna* from Macedonia is  $20\pm 0.7$  (18.9 - 21) mm in 8 males, and  $20\pm 1.5$  (18.1 - 21.8) mm in 5 females. The length of tegmina is  $23.3\pm 0.9$  (21.8 - 24.6) mm for males and  $22.5\pm 1.3$  (20.8 - 24.3) mm for females. The head width is  $5.4\pm 0.1$  (5.1 - 5.5) mm for males and  $5.5\pm 0.3$  (5.0 - 5.8) mm for females. The width of pronotum is  $6.6\pm 0.3$  (6.1 - 7) for males and  $6.6\pm 0.5$  (5.9 - 7) mm for females.

The ground colour of the body is black with yellow and red brown markings. The body is sparsely covered with golden pubescence and some longer hairs.

The **head** is black with yellow epicranial suture and in most cases with a small yellow patch at the basis of frontoclypeal suture. The postclypeus is black with exception of the yellow to brown lateral edges near the antennal base. Rostrum reaches the distal end of the second coxae (Fig. 5).

The **pronotum** is black, in some specimens with a narrow yellow line on the proximal edge and in one specimen with a faint median yellow line. The **mesonotum** is black but in 4 male and 4 female specimens there is also a narrow yellow line along the parapsidal suture with the bigger triangular patch distally. In one female this pattern is extended further distally in form of a narrow yellow line toward the **cruciform elevation**. This structure (also called scutellum) is black just in the midline and yellow till the wing groove. Adjacent parts of metanotum are yellow on both sides. Scutal depressions are black.

The striking differential characteristic of the Macedonian population of *C. concinna* is the dark **colouration of wings**. In contrast to the specimens of the typical population e.g. from Poland, where the dark colouration of wings is restricted mainly to the tip of



**Fig. 1:** Habitus of *Cicadetta concinna concinna* from Krzyżanowice, Poland.



**Fig. 2:** *Cicadetta concinna arachnocepta* ssp. nova from Suva planina, Republic of Macedonia, above male (holotype), below female (paratype).



**Fig. 3:** Males (paratypes) of *Cicadetta concinna arachnocepta* ssp. nova, left side. (The male shown in Fig. 2 is not shown again and the male from Treska gorge is prepared with closed wings and could not be photographed for this purpose. However, the melanistic colouration of it is also intense.)



front wings - as an infuscation to medial crossveins between ulnar cells 1 and 2 and the adjacent anal cells 1 to 3 (partly 4). The veins surrounding apical cell 1 and partly 2 are dark infuscated. The outer field outside the ambient vein is at the apex dark but gradually lighter toward the hind edge (Fig. 1). In cicadas from Macedonia all veins RA1, RA2, M1 - 4, CuA1 and CuA2 of tegmina are surrounded by dark infuscations. The edge of the wings outside the ambient veins on front wings and the 2A+3A veins of clavus are dark and shaded. Internodal line is on crossings with veins dark emphasised (Fig. 2). The variability of the wing colour pattern in the Macedonian population should not be neglected but only one male specimen out of 11 and one female specimen out of 5 have the pattern resembling the wing pattern of *C. concinna concinna*.

On hind wings this infuscation is around and outside the ambient vein not so strong and is mainly restricted to the tip of the wing and to the distal end of the radius anterior. Also the anal vein 2 and adjacent parts of ambient vein are at least distally gradually dark infuscated (Figs. 2, 3 and 4).



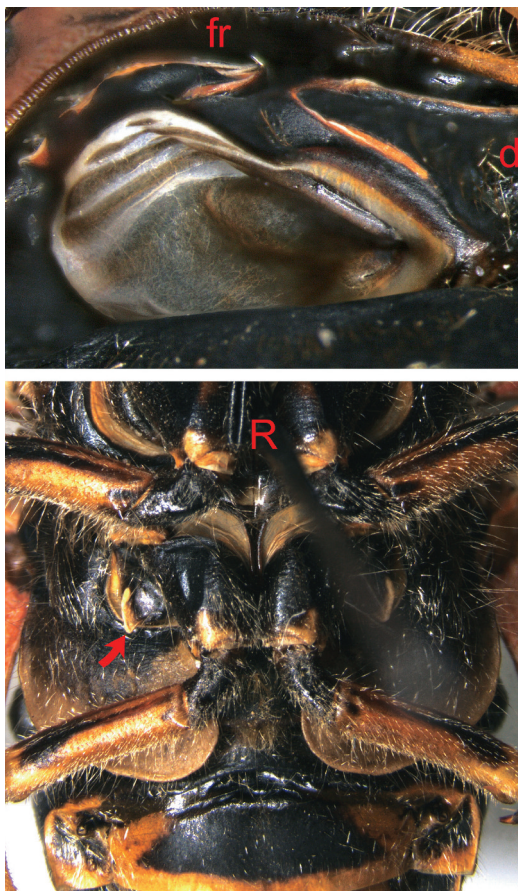
**Fig. 4:** Females (paratypes) of *Cicadetta concinna arachnocepta* ssp. nova, left side. (Also here the female shown in Fig. 2 is not shown again and the female from Treska gorge is prepared with closed wings and could not be photographed for this purpose. However, the melanistic colouration of it is also intense.)

The number of **apical cells** is in Macedonian population as well as in typical *Cicadetta concinna concinna* usually in front wings 8 and in hind wings 6. However, among the Macedonian specimens in one male out of 7 the number of apical cells on the left front wing is 10 and on the right hind wing 7 and another male has rudimentary median vein  $M_{3+4}$  and therefore 5 apical cells on one side of hind wings (Fig. 3). The first female collected in 2000 (see above) has on hind wings on both sides only 5 apical cells, another female has 9 apical cells on the left tegmen and other two females have a normal number 8 and 6 on both sides of the wings (Fig. 4).

The **legs** do not offer any differential characters between the *C. c. concinna* and *C. concinna arachnocepta* and do not differ between sexes. Front femora have one primary and two secondary spines. In some specimens also a small third secondary spine is present. Coxae are more or less dark with yellow edge at the joints. Front femora have brown and yellow longitudinal markings, other femora are more or less brown, tibiae are yellow, proximally darker and tarsi are also more or less yellow and brown.

Following morphological characters differ between sexes.

**Fig. 5:** Abdominal and sternal structures of *Cicadetta concinna arachnocepta* ssp. nova, above: left timbal, below: male with opercula and meracanthus. fr - frontal side, d - dorsal side, R - tip of rostrum, arrow - pointing to the right meracanthus.



**MALES:**

**Operculum** is reniform, yellow, darker at the basis. **Meracanthus** is more or less triangular, flat, with outer lateral edge folded up (curled, Fig. 5).

**Timbal** has similar structure as in other species of *Cicadetta montana* s. lato. It has a large timbal plate, 2 long and 2 shorter ribs (Fig. 5). Tergites of the **abdomen** are proximally black (about one half to two thirds), distally reddish brown. Along the dorsal midline black colouration is extended further distally. Abdominal sternites are more or less yellow, basally darker, especially stIII, next sternites less and less. Epipleurites similarly as tergites proximally dark, distally yellow. Sternite stVIII 1.6 - 2 times longer than stVII.

The **male genital segment** does not differ from the typical *C. c. concinna* described by Schedl (1986). In the Fig. 6 we show the shape of the male genital segment of the Macedonian specimen.

Uncus is black, triangular with rounded tip, claspers bent ventrolaterad, pseudoparamers of the aedeagus long, slightly flattened and sharply pointed. Basis of aedeagus slightly arcuate.





**Fig. 6:** Male genital segment of *Cicadetta concinna arachnocepta* ssp. nova (left: lateral view, and right: ventral view).

#### FEMALES:

The **female genital segment** is shown in Fig. 7 and corresponds with the description of Schedl (1986) for the typical *C. c. concinna*.

We did not find any other differential morphological characters in addition to the strikingly different wing colouration of the Macedonian population of *Cicadetta concinna* distinguishing them from specimens of the same species from Poland.

#### Acoustics:

The general pattern of the calling song is similar to the song of *Cicadetta concinna concinna* from Poland, described earlier (Trilar & Gogala 2007, Gogala 2013) with phrases comprising sequence of short echemes (SE) followed by a long echeme (LE) (Fig. 8).

184 phrases were measured. In two cases we could analyse only the beginning of the phrases, and reversely in ten cases we could not record the starting part of phrases. Therefore there were 172 phrases complete that could be used to measure all parameters inside phrases (phrase duration, SE part duration, No. SE in a phrase, 1<sup>st</sup> SE duration, interval after 1<sup>st</sup> SE). As described earlier (Gogala & Trilar 2004, Gogala et al. 2005, Trilar & Gogala 2007) typical phrases of the song of *Cicadetta concinna arachnocepta* ssp. nova also comprise a series of short echemes, followed by one long echeme. In two cases we recorded phrases with 2 LE at the end what can be considered also as a long echeme with a short interruption. The first echeme in a sequence of SE is usually shorter than the rest and the last SE in a phrase is usually longer than preceding ones. In 17 phrases the last SE in a phrase preceding LE did not differ from the other short echemes in a sequence (8.9%) and in 4 phrases there were 2 prolonged SE at the end (2.1%).

In the following tables we are presenting the measurements of acoustic parameters first for *Cicadetta concinna arachnocepta* ssp. nova (Macedonia) and for comparison the data for *C. c. concinna* (Poland).



Acoustic parameters for the song of *Cicadetta concinna arachnocepta* ssp. nova (Macedonia)

|                                    |   |
|------------------------------------|---|
| phrase duration                    | 3.5±1.1 s (min. 0.9 s, max. 8.0 s, N=169)             |
| SE part duration                   | 1.9±0.9 s (min. 0.7 s, max. 5.9 s, N=169)             |
| LE duration                        | 1.5±0.5 s (min. 0.4 s, max. 2.9 s, N=174)             |
| No. SE in a phrase                 | 23±9.6 (min. 8, max. 60, N=169)                       |
| 1 <sup>st</sup> SE duration        | 13.3±4.7 ms (min. 3.7 ms, max. 27.6 ms, N=181)        |
| SE duration                        | 19.5±3.9 ms (min. 4.1 ms, max. 34.4 ms, N=3468)       |
| duration of SE preceding LE        | 25.4±4.8 ms (min. 18.0 ms, max. 43.5 ms, N=178)       |
| intervals after 1 <sup>st</sup> SE | 93.4±28.6 ms (min. 56.0 ms, max. 236.4 ms, N=179)     |
| intervals between SE               | 69.8±12.3 ms (min. 33.7 ms, max. 168.9 ms, N=3465)    |
| interval preceding last SE         | 42.9±12.9 ms (min. 15.5 ms, max. 84.2 ms, N=179)      |
| interval preceding LE              | 22.4±12.6 ms (min. 5.2 ms, max. 70.3 ms, N=179)       |
| pause between phrases              | 886.5±711.9 ms (min. 227.9 ms, max. 4373.4 ms, N=158) |

Acoustic parameters for the song of *Cicadetta concinna concinna* (Poland)

|                                    |  |
|------------------------------------|--|
| phrase duration                    | 3.3±0.9 s (min. 1.2 s, max. 5.2 s, N=75)         |
| SE part duration                   | 1.6±0.6 s (min. 0.7 s, max. 2.9 s, N=75)         |
| LE duration                        | 1.6±0.6 s (min. 0.4 s, max. 2.6 s, N=91)         |
| No. SE in a phrase                 | 19±6.5 (min. 9, max. 35, N=75)                   |
| 1 <sup>st</sup> SE duration        | 10.5±3.9 ms (min. 4 ms, max. 21 ms, N=91)        |
| SE duration                        | 16.9±3.5 ms (min. 4 ms, max. 28 ms, N=2079)      |
| duration of SE preceding LE        | 20.4±4.0 ms (min. 11 ms, max. 30 ms, N=93)       |
| intervals after 1 <sup>st</sup> SE | 72.7±9.8 ms (min. 50 ms, max. 110 ms, N=90)      |
| intervals between SE               | 69.6±10.1 ms (min. 28 ms, max. 165 ms, N=1885)   |
| interval preceding last SE         | 42.7±11.1 ms (min. 17 ms, max. 89 ms, N=92)      |
| interval preceding LE              | 23.4±11.3 ms (min. 6 ms, max. 85 ms, N=92)       |
| pause between phrases              | 641.4±573.6 ms (min. 201 ms, max. 3168 ms, N=90) |

A summary comparison of acoustic data for both populations of *C. concinna*

|                             | <i>C. c. arachnocepta</i> ssp. n. | <i>C. c. concinna</i> |
|-----------------------------|-----------------------------------|-----------------------|
| phrase duration             | 3.5±1.1 s                         | 3.3±0.9 s             |
| SE part duration            | 1.9±0.9 s                         | 1.6±0.6 s             |
| LE duration                 | 1.5±0.5 s                         | 1.6±0.6 s             |
| No. SE in a phrase          | 23±9.6                            | 19±6.5                |
| 1 <sup>st</sup> SE duration | 13.3±4.7 ms                       | 10.5±3.9 ms           |
| SE duration                 | 19.5±3.9 ms                       | 16.9±3.5 ms           |

|                                    | <i>C. c. arachnocepta ssp. n.</i> | <i>C. c. concinna</i> |
|------------------------------------|-----------------------------------|-----------------------|
| duration of SE preceding LE        | 25.4±4.8 ms                       | 20.4±4.0 ms           |
| intervals after 1 <sup>st</sup> SE | 93.4±28.6 ms                      | 72.7±9.8 ms           |
| intervals between SE               | 69.8±12.3 ms                      | 69.6±10.1 ms          |
| interval preceding last SE         | 42.9±12.9 ms                      | 42.7±11.1 ms          |
| interval preceding LE              | 22.4±12.6 ms                      | 23.4±11.3 ms          |
| pause between phrases              | 886.5±711.9 ms                    | 641.4±573.6 ms        |

The differences in song parameters of both populations of *C. concinna* are not statistically important and hardly justify the discrimination of separate subspecies.

### Conclusion:

On the basis of obvious morphological characters mentioned above and due to less evident acoustic differences to the typical population from Poland, we are describing the isolated population of *C. concinna* from Suva planina and the Treska gorge in Macedonia as a separate subspecies *Cicadetta concinna arachnocepta ssp. nova*.

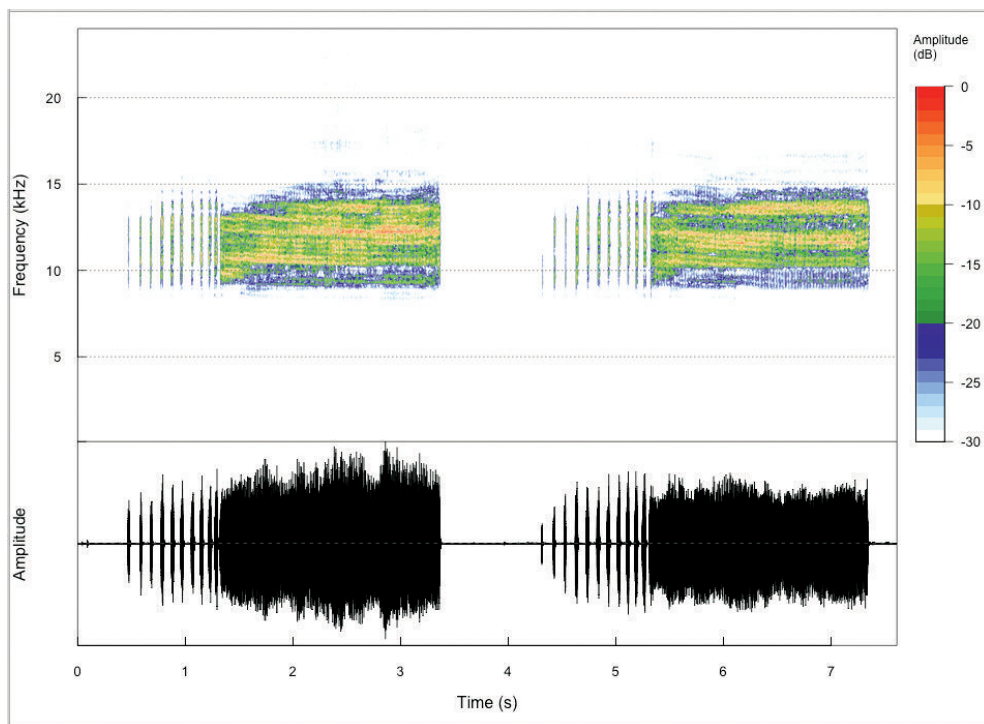
**Etymology:** *arachnocepta* means in Latin “caught by a spider” in reminiscence to the discovery of the first specimen.

### Ecology

The habitat of the *C. c. arachnocepta ssp. nova* is in the dry grassland above the Treska gorge (Fig. 9). “Suva planina” means a dry mountain. This region is still in a good ecological condition and therefore it is not endangered at the time being. This can of course change very quickly with some extensive development plans. In such a case the further existence of this unique taxon of cicadas would be endangered.



**Fig. 7:** Female genitalia of *Cicadetta concinna arachnocepta ssp. nova*, left profile, right ventral view.



**Fig. 8:** Oscillogram and sonagram (above) of the calling song of *Cicadetta concinna arachnocepta* ssp. nova.

## Discussion

First, we should mention again that the valid name for the species discussed above is *C. concinna* Germar 1821 as stated by Boulard (1981) and confirmed by Shydlovskyy & Holovachov (2005, compare also Gogala 2013). We investigated in the field in addition to the new Macedonian subspecies only the population of *C. c. concinna* near Krzyżanowice in Poland. However, the type(?) specimens of Germar from Podolia (Shydlovskyy & Holovachov 2005) and the specimens we have seen and photographed in the collections of the Senckenberg German Entomological Institute (SDEI) in Müncheberg, Germany and in Saint Petersburg museum from Ukraine and Russia, at least in wing colouration do not differ from the Polish specimens. The same is true for the specimen from Budapest museum collected near Kolozswar (now Cluj-Napoca in Romania) as well as the comparative material from MNHN in Paris. We could not find specimens preserved in other museums with such dark melanistic wing colouration.

Acoustic pattern of the new subspecies with a sequence of short echemes and following one long echeme in a phrase reminds of some other taxa of *Cicadetta montana* complex of species. We mentioned this group of species as a “macedonica”

group (Gogala 2013, pp. 154-7). However, the differences to the song structure of other species of this group, except to *C. c. concinna*, are evident and not easy to overlook.

Today, one would expect in such kind of a taxonomic research to use in addition to morphological and acoustical methods also molecular studies. We sent the samples of *Cicadetta concinna concinna* and *C. c. arachnocepta* ssp. nova to the laboratory of Chris Simon (Storrs, USA) for investigation. The preliminary results based on examination of COI and COII of some eastern European species of *Cicadetta montana* complex of species, clearly discernible by morphology and bioacoustics, *C. macedonica*, *C. hannekeae*, *C. dirfica* and also both *C. concinna concinna* and *C. c. arachnocepta* ssp. nova could not be sufficiently resolved (B. Wade from the same laboratory, personal communication). Therefore, molecular data could not bring yet more light to the question, which taxonomic level should be ascribed to the population of *C. concinna* from Macedonia. Further molecular research is needed.

It is also interesting that *C. concinna arachnocepta* ssp. nova occurs on Suva Planina near Nova Breznica at the same time period and on the same meadows as closely related *C. cantilatrix* Sueur & Puissant 2007 and very close to the shrubs with another species of “mountain cicada”, *C. macedonica* (Schedl 1999).

Among the specimens of *C. c. arachnocepta* from Suva planina we observed a quite high morphological variability (Figs. 3, 4), what can be a consequence of the



**Fig. 9:** Habitat of *Cicadetta concinna arachnocepta* ssp. nova on Suva Planina, Republic of Macedonia.



small population size. We have observed irregularities in venation of the wings as well as differences in colouration.

The fact that Macedonian population of *C. concinna* differs mainly in colouration of wings, and also the song structure does not show any substantial differences, we find that this population, restricted to the small region on Suva planina and along the Treska gorge should be considered as a subspecies. Further molecular investigations of this two taxa might in future bring more certainty to this decision.

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