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The East Palaearctic genus *Uvarovina* (Orthoptera: Tettigoniidae): Taxonomic remarks and bioacoustics

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Abstract

The East Palearctic genus *Uvarovina* comprises two species. However, their identification can sometimes be difficult, even when using all available information. The type localities of *U. daurica* and *U. chinensis* are situated at the opposite edges of the genus' range, where the species can be diagnosed easily. In other parts of their range the situation is more complicated, sometimes with contradictory diagnostic characters. The type species *U. daurica* (Uvarov, 1928) is removed from the synonymy with *Peltastes venosus* Fischer von Waldheim, 1839. The calling song consists of long sequences of short, isolated syllables.

Key words

calling song, genitalia

Introduction

The genus *Uvarovina* contains two species, *U. daurica* and *U. chinensis*, distributed in the Eastern Palearctic. Both are relatively small forms with a body length of less than 2 cm (see Fig. 1 for the habitus of *Uvarovina daurica*). Despite being found in a relative large area of Mongolia, Russia and China (Fig. 2), not much is known about the genus. During the few expeditions where it was found at all, only a limited number of specimens have been collected. Concerning the systematic affiliation of the genus the opinions differ. It belongs undisputedly to Tettigoniinae (shield-backed katydids) as this subfamily is understood at present, but it is put into different tribes depending on author. Originally described as closely related to *Drymadusa* ("group Drymadusa" Ramme 1939) and in ovipositor shape similar to the Drymadusini genus *Atlanticus* (Bey-Bienko 1955), Rentz & Colless (1990) listed it with Platycleidini, Storozhenko (2004) with Bergiolini, and Heller & Korsunovskaya (2009) consider Bergiolini as belonging to Drymadusini. From morphology alone all these groups are very difficult to differentiate (see Rentz & Colless 1990, Heller & Korsunovskaya 2008).

The genus *Uvarovina* was based on the type species *Bergiola daurica* Uvarov, 1928 (Ramme 1939). Recently this species was synonymised with *Peltastes venosus* Fischer von Waldheim, 1839 (Storozhenko 2004). According to most other authors, beginning with Brunner von Wattenwyl (1861) until *e.g.*, Kaya *et al.* (2013), this species is considered a member of the very different genus, *Psorodonotus*. An explanation for this difference and a discussion about its significance is given below in Taxonomic Remarks, together with a description of identification problems of both species of the genus. In addition we present detailed information about the calling song in *Uvarovina*.

At the moment only limited data exist about the biology of the genus. According to some ecological observations made by Bey-Bienko (1955) and Kang *et al.* (1989), both species are typical inhabitants of grassland in Inner Mongolia with ecological requirements similar to the acridid *Aeropedellus variegatus minutus* (Kang *et al.* 1989). According to Liu & Sui (2008) they also occur in grassland with bushes and stones. They are even considered as important indicators of grassland degradation and desertification, and occur often together with the plant species *Carex nigrescens* (synonym of *Carex norvegica subsp. norvegica*?) and *Artemisia sacrorum mandshurica* (Bey-Bienko 1955). Both *Uvarovina* species live in the same habitat (Kang *et al.* 1989), but in neighbouring geographical areas (Kang *et al.* 1990). Liu & Sui (2008) reported that in captivity they feed on *Artemisia* and cucumber, and described the song of *U. daurica* verbally as "Ji-Ji-Ji-Ji-Ji-Ji...." or "Jia-Jia-Jia-Jia-Jia....".

Materials and methods

Specimens were recorded and collected at two localities in Mongolia.

U. chinensis. CH5341-2; 1 male, 1 female, MONGOLIA: Töv Aimag, small pass 15 km west of Lün (47°48′N, 105°6′E), 25 viii 1997, leg. K.-G. Heller.

Specimen with *U. daurica* like cerci, called *U.* cf. *daurica*. CH5329, 1 male, MONGOLIA: Selenge Aimag, valley ca. 20 km eastnortheast of (D)Züünkharaa (48°54′N, 106°42′E) [estimated from map], 1050 m, 19 viii 1997, leg. K.-G. Heller. The locality was near the biological station Khonin Nuga (see https://www.uni-goettingen.de/de/research-station/117646.html; 49°05′17″N and 107°17′36″E), 930 m a.s.l.

In addition, we studied a male paratype of *U. chinensis* in Museum für Naturkunde (MfN) in Berlin.

The animals were recorded in the field (*U.* cf. *daurica* only) and in the laboratory (both species) using an UHER M645 microphone and a cassette type recorder SONY WM-D3.

Song measurements were obtained using CANARY (http://www.birds.cornell.edu/brp/), AMADEUS II and AMADEUS Pro (Martin Hairer; http://www.hairersoft.com). Oscillograms of the songs were prepared using TURBOLAB (Bressner Technology, Germany). In the laboratory the singers were caged in plastic tubes with microphone fixed or hand held at distances between 5 and 60 cm. Due to limited equipment no data are available about the spectral composition of the song. Data are presented as mean ± standard deviation (in each case 10-12 measurements).

Terminology.— Syllable: sound assumed to be produced during one cycle of movements (opening and closing of the tegmina); syllable period: time period from one syllable beginning to the next (reciprocal value: syllable repetition rate, SRR); duty-cycle: percentage

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Fig. 1. Male of *Uvarovina daurica* (photos O. Korson, reproduced with permission). For color version, see Plate V.

of time with active sound emission; impulse: a simple, undivided, transient train of sound waves (here: the damped sound impulse arising as the impact of one tooth of the stridulatory file).

Results

Taxonomic Remarks

The case of *Peltastes venosus* Fischer von Waldheim, 1839
Uvarovina daurica (Uvarov, 1928) stat. rev.

When describing *Peltastes venosus*, Fischer von Waldheim (1839) presented colored figures for male and female (see Fig. 3) and mentioned "Dauria" as region of origin. Shortly afterwards (1846), he transferred the species to *Olynthoscelis* (which included *Peltastes* and *Pterolepis*). In the year 1861, Brunner von Wattenwyl introduced the genus *Psorodonotus* and included there also *Pterolepis venosa* Fischer von Waldheim, although with a question mark. He came to this decision probably using the figures in the paper of Fischer von Waldheim (1839). Later, Kirby (1906) and Caudell (1908) listed the species as *Psorodonotus venosus* from Irkutsk, probably following Jacobson & Bianchi (1903; paper not seen). In the revision of *Psorodonotus*, Ebner (1923) re-described the species using specimens from the Caucasus, determined by Brunner von Wattenwyl as *Ps. venosus*. In addition, Ebner cited a letter from Uvarov who was convinced that Fischer von Waldheim's statement "Dauria" was not correct and that the specimens were found in Caucasia. Since even up to now no specimens of the genus have been found in Central Asia, this opinion is obviously correct. Stolyarov (1983) even considered the localities of the specimens used by Ebner as type localities for *Ps. venosus venosus*.

Storozhenko (2004) synonymized *U. daurica* (Uvarov, 1928) with *Peltastes venosus* Fischer von Waldheim, 1839, because the description of this species, consisting of eight Latin words, might be applicable to *U. daurica*, too. However, from the figures given by Fischer von Waldheim it is clear that the author did not have specimens of *Uvarovina* at hand. The male especially differs distinctly in coloration as well as in shape and size of pronotum and tegmina. In addition, in the diagnosis of the genus *Peltastes* the body (Latin *corpus*) is described as thick (Latin *crassum*), also certainly not appropriate for *Uvarovina*.

Identification of *Uvarovina* species

Ramme (1939) erected *Uvarovina* on *Bergiola daurica* Uvarov, 1928 and added a newly described species, *Uvarovina chinensis* to the genus in the same paper. At that moment *U. daurica* was only known from the types from Transbaikalia, whereas *U. chinensis* was described from Shandong about 400 km southsoutheast of Bejing (Fig. 2). As diagnostic characters, Ramme mentioned at the first place two to four spinules on the lower inner edge of the hind femur, present only in *chinensis*. As a second diagnostic character he described and figured the shape of the male cercus. Both characters were already mentioned by Uvarov, who had sent the specimens to Ramme (Ramme 1939, p. 91). Ramme did not give any specific diagnostic characters for females. More than 60 years later and on the basis of relatively large material (nearly 40 specimens), Storozhenko (2004) gave a key and figures to distinguish both species. He did not mention the differences in femoral armature, but focused on cercal shape, length of female tegmina and shape of female subgenital plate. According to his material (he does not give exact localities) and other published data, *U. daurica* occurs in Southeast Russia, and both species in Mongolia and China, although mainly allopatric (see Fig. 2). Interestingly, the description, but also figures of the cerci, differ slightly between Ramme and Storozhenko, especially for *U. daurica*. According to Storozhenko here the inner tooth is as long as the outer part, while for Ramme the outer part is longer than the inner tooth. The two males studied here differ also slightly in this character. In the specimen from Züünkharaa both cercal parts are about the same length (as in fig. 311 of *daurica* in Storozhenko

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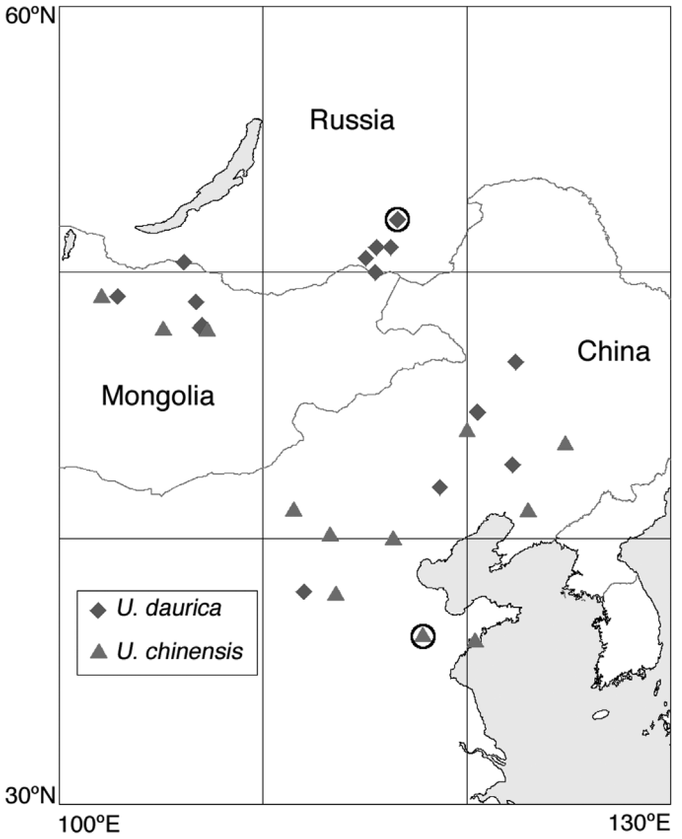


Fig. 2. Distribution map of *Uvarovina*, identification according to authors (Table 1), type localities circled.

2004), while in the male from Lün the inner part is longer (Fig. 4). Storozhenko (2004) introduced a new diagnostic character, the length of the female tegmina. In the description of the genus, Ramme (1939) wrote that the female tegmina just touch each other or not at all, but did not mention the length. From his text it is obvious that he had never seen *daurica* females. Uvarov (1928) described female *U. daurica* as having tegmina "extending a little beyond the first tergite". Storozhenko (2004) discovered an important difference, visible also in photos of type material in OSFO (2016). The female tegmina of *U. chinensis* are shorter than that of *daurica*, in this species surpassing the hind edge of the 1st tergite, in *chinensis* only reaching its middle. The female from Lün has very short wings, typical for *chinensis*, thus both specimens from that locality may belong to this species. The male cerci, however, differ in shape clearly from that of the holotype (see figure in OSFO) and a paratype of *chinensis* (see Fig. 4). Concerning the number of spinules, the male CH5329 bears three on the right and five on the left femur, while in the couple (CH5341-2) from Lün the male has three on the one femur and one on the other and the female three (only one hind femur present). So, possibly all three belong to *chinensis* despite the cercal differences. Other possibilities would be that either there is a gradual change in the characters, especially the male ones, and that only one species is present, or that more than two species are involved. It has to be remembered that the specimens from most localities shown in Fig. 2 must have been identified using the criteria given by Ramme (1939; femoral armature and cercus shape in the male, femoral armature only in the female). Günther (1970) is the only author who mentioned the number of spinules and explained that he considers a female with one spinule as *daurica*. If femoral armature would be considered as unreliable, then all the identifications based on females (8 out of 14 with known sex; see Table 1) before Storozhenko (2004) would be uncertain.

Bioacoustics

Both males were quite similar in all aspects of the acoustic behaviour. The animals were heard singing during daytime, even in bright sun (no information about nighttime activities available). Both males (observed on different days) stridulated continuously for minutes with only short intervals (longest recording 117 s). The song always consisted of isolated syllables (Fig. 5). The syllable duration and syllable repetition rate (SRR) varied with temperature. In in-door recordings SRR increased from 1.0 Hz (0.94-1.14 Hz) at 22°C (CH5341) to 1.5 Hz (1.33-1.67 Hz) Hz at 29°C (CH5329), whereas syllable duration decreased from 50±2.5 ms to 29±1.7 ms in the same temperature interval (duty cycle 4-5%). In the field recording with the animal sitting in the sun the syllables were even shorter than at 29°C in the laboratory, indicating either a higher body temperature than in the lab at that moment or a different and generally higher SRR. Surprisingly, during the long recording the animal occasionally changed its syllable periods, *e.g.*, switching with gradual transitions from 277±22 ms (3.6 Hz) to 430±25 ms and 528±38 ms, whereas at the same time the syllable duration changed only slightly (16±0.8 ms, 18±1.0, 20±1.5 ms). Of course, temperature effects (shade of a cloud?) cannot be excluded, but they may not completely explain



Fig. 3. Figures of *Peltastes venosus* from the description of this species by Fischer von Waldheim, 1839. For color version, see Plate V.

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Table 1. List of papers containing original locality data for *Uvarovina* species (including number of specimens studied and assumed co-ordinates for the localities)

Species	Author	Number of Specimens	Assumed coordinates
Uvarovina daurica	Uvarov 1928	1♂, 1♀	51.98°N, 116.58°E
"	"	2♀♀	50.53°N, 115.03°E
"	Cejchan 1968	3♀♀	47.92°N, 106.91°E
"	Günther 1970	1♀	49.1°N, 102.85°E
"	Chogsomzhav 1972	1?	not traceable
"	Ma *et al.* 1991	?	44.75°N, 120.52°E
"	Bugrov 1990	3♂♂	50.94°N, 115.56°E
"	Bazyluk 1993	2♀♀	48°N, 107°E
"	Jin & Xia 1994	?	38°N, 112°E
"	Dubatulov & Sergeev 1999	4♂♂, 5♀♀	50°N, 115.5°E
"	Storozhenko 2004	20, sex?	no exact data
"	Storozhenko 2008	1♂, 2♀♀	50.39°N, 106.10°E
"	Liu & Sui 2008	?	46.63°N, 122.38°E
"	"	?	42.77°N, 122.23°E
"	"	?	41.92°N, 118.67°E
"	Korsun 2014	1♂	50.94°N, 116.25°E
Uvarovina cf. daurica	own data	1♂	48.9°N, 106.7°E
Uvarovina chinensis	Ramme 1939	3♂♂, 3♀♀	36.3°N, 117.8°E
"	Bey-Bienko 1955	1♀	43.5°N, 124.82°E
"	"	1♀	41°N, 123°E
"	"	2♀♀	41°N, 123°E
"	"	2♂♂, 3♀♀	39.92°N, 116.38°E
"	"	4♂♂, 8♀♀	36.1°N, 120.4°E
"	Cejchan 1968	1♂, 1♀	49.04°N, 102.08°E
"	Mistshenko 1968	1♀	47.77°N, 107.25°E
"	Ma *et al.* 1991	?	44°N, 120°E
"	"	?	41.02°N, 111.5°E
"	Storozhenko 2004	17, sex?	no exact data
"	Liu & Sui 2008	1♂	40.08°N, 113.28°E
"	own data	1♂, 1♀	47.8°N, 105.1°E
"	own data	1♀	37.85°N, 113.57°E

the differences. In all recordings each syllable consisted of a series of impulses (Fig. 5 D-F).

The stridulatory file (both specimens studied) is situated on the underside of the left tegmen, which is placed above the right one as is typical for most tettigoniids. The right tegmen has a non-functional file at the lower side (with much smaller teeth than on the left), but its mirror is larger and more glossy than that on the left tegmen. The left file carries about 45 teeth, neglecting some very small ones at the anal (=distal) end. Going from the anal to the basal end of the file, the teeth and teeth intervals become increasing larger, reaching a maximum of about 45 µm at about one third of the length, and then become slowly smaller again.

Discussion

The type localities of the two species are situated at the opposite edges of the range of the genus *Uvarovina* (Fig. 2). Here males and females of the different species seem to be easily diagnosed. The situation in between is more complicated, especially for females and old records. But even in males the various diagnostic characters can be contradicting, as *e.g.*, in our male from Züünkharaa with cerci like *daurica* and spinules like *chinensis*.

According to the distribution records and the identification, the two species are not strictly allopatric. However, they have never been found together despite quite close localities and similar ecological requirements. Expected from previous studies, our specimens were found in open grassland. At Khonin nuga where *U.* cf. *daurica* was collected the steppe was probably never used as pasture and is – at least in most places – not degraded, but borders the forest. Here "montane meadow and mountain steppes cover south-facing slopes, whereas north-facing slopes and valleys are stocked with forest" (Dulamsuren 2010). The area has a high diversity of acridid grasshoppers (own data) but it cannot be excluded that *Uvarovina* was found at a locally very sparsely vegetated place. At the pass near Lün, however, the vegetation was poor as may be expected from Kang *et al.* (1989). Again, more data are necessary to understand if there is an ecological difference between the species.

With the available knowledge about the songs, bioacoustics will not help for identification. Both specimens studied had very similar calling songs. More recordings made under well defined conditions will possibly reveal significant species-specific differences in the amplitude pattern. Our specimens may belong to the same species despite the cercal differences (see above). However, also for allopatric species similar song patterns are to be expected (Heller 2006). This is especially true if the titillators, the sclerotized internal male genitalia, do not show differences (Storozhenko 2004). For the observed differences in song, temperature effects cannot be completely excluded, even if then the body temperature for *U.* cf. *daurica* must be assumed to have been unusually high. Certainly more recordings from other localities and at other temperatures are required to resolve subtle differences. The verbal description of the song by Liu & Sui (2008) agrees quite well with our recordings.

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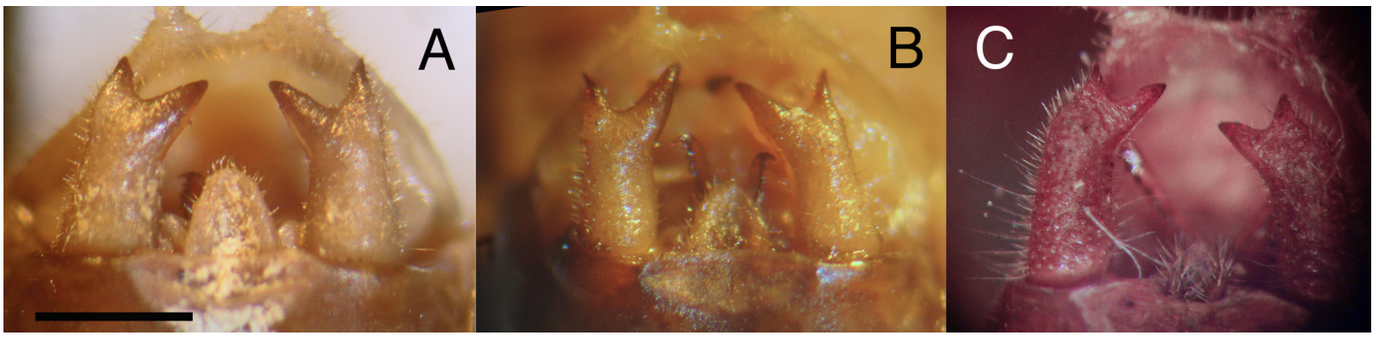


Fig. 4. Male cerci in *Uvarovina*. A: *U.* cf. *daurica* from Züünkharaa, B: *U. chinensis* from Lün, C: paratype of *U. chinensis* (MfN). Scale 5 mm. For color version, see Plate V.

They also heard them singing at night.

Bush-cricket calling songs consisting of one syllable repeated in regular intervals are not common among Tettigoniinae, but also not really rare. For example, such monosyllabic songs are known from all members of the genera *Eupholidoptera* Ramme, 1951 (Ciplak *et al.* 2009), *Tessellana* Zeuner, 1941 (Heller 1988; as *Platycleis*, subgenus *Tessellana*) and *Thyreonotus* Serville, 1839 (Heller 1988). If there are any species-specific differences, they are found in syllable durations and intervals. In some genera monosyllabic songs are also observed beside song patterns containing chirps or trills (*e.g.*, *Pachytrachis* Uvarov, 1940 and *Antaxius* Brunner von Wattenwyl, 1882; Heller 1988). None of these examples refers to a species of Drymadusini. However, also in this tribe monosyllabic songs are found, *e.g.*, in *Drymadusa dorsalis* (Brulle, 1832) (Heller 1988) and *Scotodrymadusa syriaca* (Pictet, 1888) (Ciplak & Heller 2005). So the question of the tribal affiliation of *Uvarovina* remains open.

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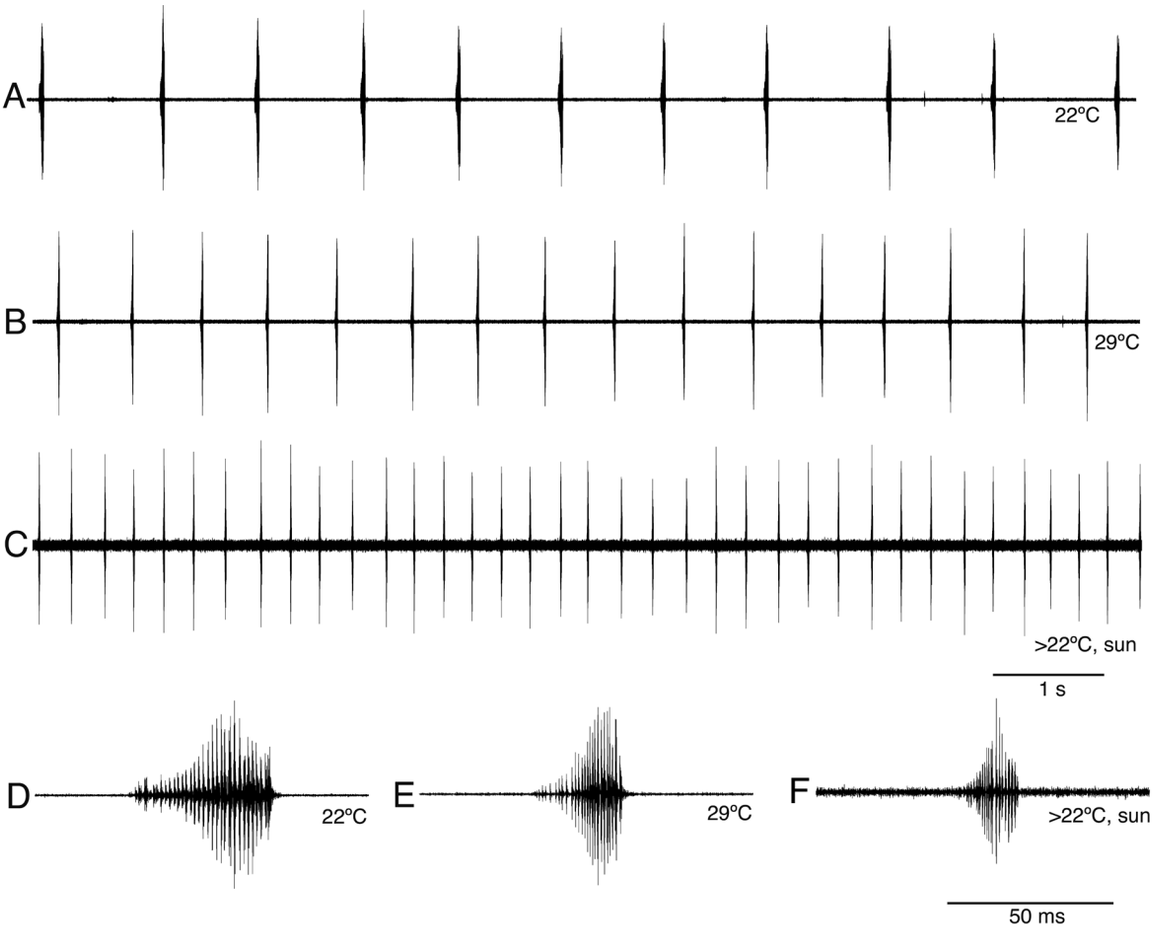


Fig. 5. Oscillograms of the calling song of Mongolian *Uvarovina* at different temperatures and time scales. A-B, D-E: *U. chinensis;* C, F: *U.* cf. *daurica*.

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