

Contribution to the bioacoustics of little known katydids (Orthoptera: Tettigoniidae) from Central Asia

К биоакустике малоизученных кузнечиков (Orthoptera: Tettigoniidae) из Средней Азии

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КЛЮЧЕВЫЕ СЛОВА: Orthoptera, кузнечики, *Conocephalus*, *Platycleis*, акустические сигналы, морфология, распространение.

ABSTRACT. The temporal and frequency parameters of the calling songs of male Central Asian bush-crickets *Conocephalus concolor buxtoni* and *Platycleis pamirica* were studied. Scanning electron micrographs of their sound producing apparatus and photographs of some morphological structures used as diagnostic characters are presented. *Conocephalus concolor buxtoni* was recorded for the first time in Turkmenistan and Uzbekistan, and *Platycleis pamirica* in Kazakhstan.

РЕЗЮМЕ. Изучены временные и частотные параметры призывных сигналов самцов среднеазиатских кузнечиков *Conocephalus concolor buxtoni* и *Platycleis pamirica*. Приведены электроннограммы их звукового аппарата и фотографии некоторых морфологических структур, используемых в качестве диагностических признаков. *Conocephalus concolor buxtoni* впервые указан для территории Туркмении и Узбекистана, а *Platycleis pamirica* — для Казахстана.

Introduction

The sound signaling of Central Asian long-horned orthopterans have been extremely poorly studied. The few studies devoted to individual species (see e.g., Tishechkin & Korsunovskaya [2023]; Korsunovskaya [2024b]). At the same time, this largely inaccessible region is rich in endemic species, so each new study makes a significant contribution to both bioacoustics and orthopterology in general.

Material and Methods

Insects for song recordings were collected in the following localities.

Conocephalus concolor buxtoni Chopard, 1921: 1 male. S Turkmenistan, vill. Dushak (N, 37.19° E, 60.01°), VIII.1988, O. Korsunovskaya leg.

Platycleis pamirica (Zeuner, 1930): 2 males. Kazakhstan: N Tien Shan, Almaty nature reserve (N, 43.1° E, 77.32°).

Acoustic signals were recorded by use of microphones Bruel&Kjaer 4135 (frequency response flat up to 100 kHz), with amplifier Bruel & Kjaer 2604 and ultrasound tape recorder modified in lab (Yupiter-202 S) (up to 70 kHz). The sound signals were digitized by use of analogue-to-digital converter E-14 440 (L-Card, Russia) with sampling rate of 30303, 100000 or 142857 Hz. Oscillograms, frequency spectra and sonograms were obtained using CoolEditPro 2.1, Turbolab 4.2 and PowerGraph 3.3 softwares. Averaged data are presented with standard error, calculated over at least 20 measurements.

Photographs were taken by a Canon EOS 6D Mark II digital camera with a Canon DS126631macrolens. Before photographing of the titillators they were dissected, kept overnight in a 10% KOH solution, washed in distilled water and placed in glycerol. Scanning electron micrographs (SEMs) of specimens were made with a JEOL/EOScanning electron microscope (Japan) (Electron Microscopy Laboratory, Faculty of Biology, Lomonosov Moscow State University).

At description of sound signals we mainly follow bioacoustic terminology used by Baker & Chesmore [2020] and Heller *et al.* [2021]. Calling song: spontaneous song produced by an isolated male. Syllable: the sound produced by one complete up (opening) and down (closing) stroke of the forewings (tegmina). Hemisyllables — parts of syllable corresponding to each unidirectional movement of tegmina. Tooth-impact — short sound impulse arising during contact of a single tooth

of the stridulatory file (pars stridens) with the plectrum. Click – fast train of sound waves arising at striking any structures. Series: group of several syllables.

Results and discussion

Conocephalus (Anisoptera) concolor buxtoni Chopard, 1921

Male cercus important for species diagnostics is presented in Fig. 1.

DISTRIBUTION. It covers Western and Central Asia: Iran, Iraq, Afghanistan, Turkmenistan (Dushak, new record), Uzbekistan (Uch Kysyl near Termez, VII 1991, Savitsky leg., new record).

SONG (Figs 4–9). The male's calling signal is an alternating sequence of syllables of varying amplitude: low-amplitude syllable series (Fig. 7) and high-amplitude single syllables (Figs 5, 6) or groups of 2–3 syllables. Each syllable consists of a quiet and very short (about 3 ms) opening hemisyllable and a loud closing hemisyllable (hereinafter referred to as a syllable). Series consist of several syllables (from 7 to 10 in our experiments) with a repetition rate of $22 \pm 1 \text{ s}^{-1}$. The duration of low-amplitude syllables (in series) at 23°C is $22.7 \pm 0.8 \text{ ms}$, while that of single syllables is $50.4 \pm 0.9 \text{ ms}$. Closing syllables in series contain 12–14 clicks (tooth-impacts), single ones — about 30. The tooth-impacts repetition rate in syllables of different amplitudes varies — in series-forming syllables it is relatively constant and amounts to about 400 s^{-1} , in single syllables the tooth-impacts repetition rate increases towards their middle, where it reaches almost 1000 s^{-1} , and then decreases.

The signal is similar to the sounds of *Conocephalus* (*Conocephalus*) *conocephalus* (e.g. Hemp, [2021], Korsunovskaya [2024a]), since it also features alternating pulses of different amplitudes, but the loud elements in *C.(A.) buxtoni* do not form long trill-like fragments

The frequency spectrum occupies a wide frequency band (Figs 8–9), the upper limit of which extends to 50–60 kHz. The spectra of single loud and quiet (in series) syllables differ slightly: loud syllables have two maxima — around 17–18 kHz (the dominant frequencies) and 25 kHz (Fig. 8); in quiet syllables, the dominant frequencies are also around 17 kHz, and the ultrasonic maximum is very weak (Fig. 9).

SOUND PRODUCING APPARATUS. In the male specimen studied, the stridulatory file (pars stridens) consists of 51 teeth (Fig. 10). Their density is greatest at both ends of the file. In its middle part, the teeth are larger and less densely spaced.

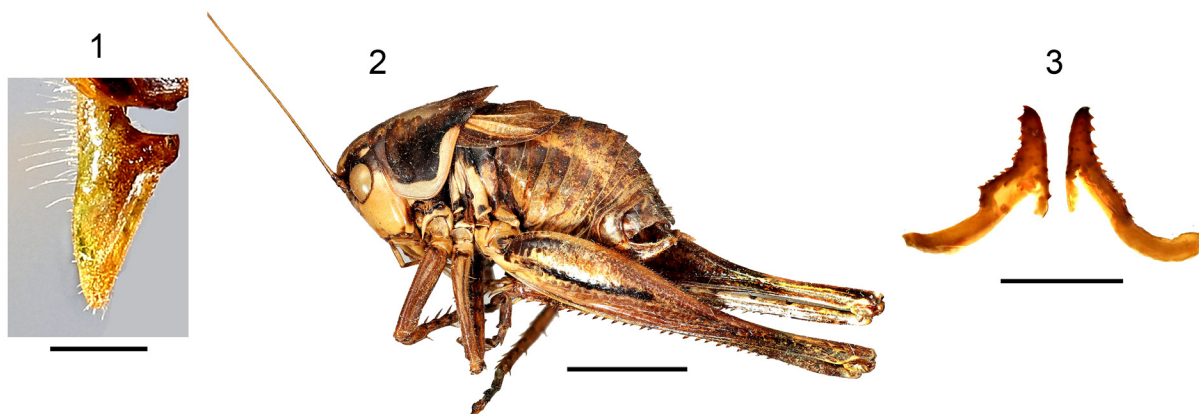
Platycleis pamirica (Zeuner, 1930)

Male habitus and titillators are presented in Figs 2 and 3.

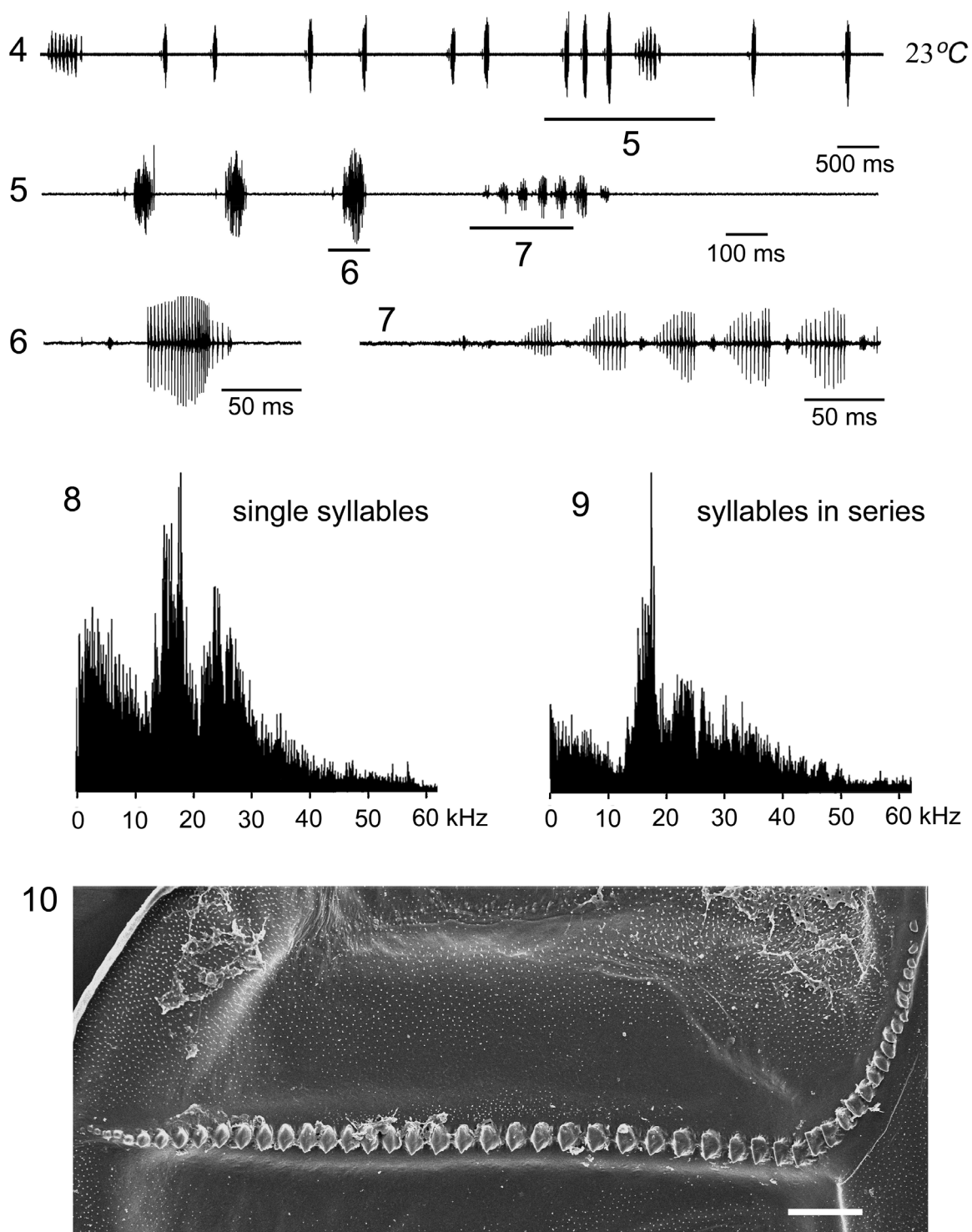
DISTRIBUTION. Central Asia: Tadzhikistan: W Pamir, Altyn-Masar (type locality), Kazakhstan: N Tien Shan (new record).

SONG (Figs 11–15). The male's sound signal consists of two- and occasionally three-syllabic series (Figs 11–13). Their duration is $326 \pm 4 \text{ ms}$. Sometimes, before the closing hemisyllable, an opening microhemisyllable and 1–2 clicks are noticeable — these are apparently accompanied by muscle contractions, the amplitude of which is insufficient to produce a full syllable. Males that hear each other synchronize their singing, with the syllables almost completely coinciding in time. Each syllable consists of an opening and a closing hemisyllable. However, the opening of the tegmina is often silent, and the corresponding hemisyllable is not expressed. At 22°C , the duration of the first closing hemisyllable in a series is $95 \pm 5 \text{ ms}$, the second one $91 \pm 2 \text{ ms}$, with an interval of $54 \pm 3 \text{ ms}$ between them. The repetition rate is approximately 6 s^{-1} .

In the frequency spectrum (Fig. 14), the dominant frequencies are 14–16 kHz. In addition, there are high-

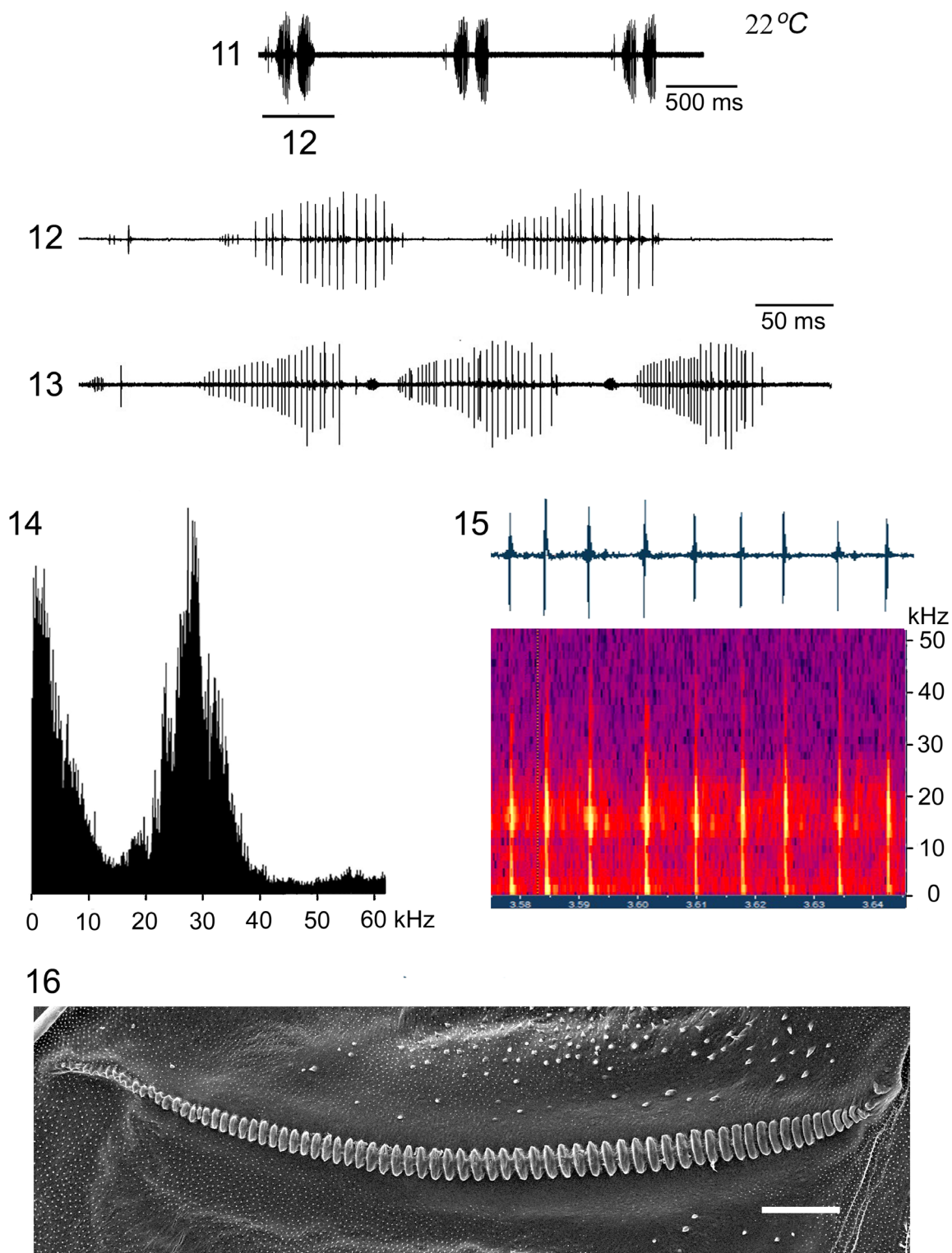


Figs 1–3. Left male cercus (1) of *C. c. buxtoni*, habitus (2) and titillators (3) of *P. pamirica* male. Scales 1 mm (1, 3) and 5 mm (2).
Рис. 1–3. Левый церк самца *C. c. buxtoni* (1), внешний вид (2) и титилляторы (3) *P. pamirica*. Масштаб 1 мм (1, 3) и 5 мм (2).



Figs 4–10. Oscillograms (4–7), frequency spectra in linear scale (8, 9) and scanning electron micrograph of stridulatory file (10) of *C. c. buxtoni*. Scale 200 μm .

Рис. 4–10. Осциллограммы (4–7), частотные спектры в линейном масштабе (8, 9) и электроннограмма стридуляционной жилки (10) *C. c. buxtoni*, масштаб 200 мкм.



Figs 11–16. Oscillograms (11–13), frequency spectrum in linear scale (14), signal fragment with duration 7 s (top) and sonogram (bottom) (15); scanning electron micrograph of stridulatory file (16) of *P. pamirica*. X-axis in spectrum (14) — sound frequency, kHz, in sonogram (15) — time, min; Y-axis (15) — sound frequency, kHz; scale (10, 16) 200 μm.

Рис. 11–16. Осциллограммы (11–13), частотный спектр в линейном масштабе (14), фрагмент сигнала длительностью 7 с и сонограмма (внизу) (15); электроннограмма стридуляционной жилки (16) *P. pamirica*, масштаб 200 мкм. По оси абсцисс на спектре (14) — частота звука, кГц, на сонограмме (15) — время, мин, по оси ординат (15) — частота звука, кГц.

amplitude low-frequency components in the range of 0.2 to 12 kHz with a maximum at 1–3 kHz (see sonogram in Fig. 15).

SOUND PRODUCING APPARATUS. The stridulatory file of the examined male contains 77 teeth (Fig. 16). Approximately one-quarter of the file from the anal edge of the tegmen is formed by small teeth, gradually increasing in size toward the midpart of pars stridens.

Competing interests. The author declares no competing interests.

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