INT. J. BIOL. BIOTECH., 21 (3): 317-323, 2024.

ANALYSIS OF MALE CALLING SONGS OF CRICKETS *ACANTHOGRYLLUS BRUNNERI* (SAUSSURE) (ORTHOPTERA: GRYLLIDAE) WITH REFERENCE TO THEIR REGIONAL VARIATION AND ITS IMPACT ON THEIR SYSTEMATICS

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ABSTRACT

In this paper, we report the collection of specimens of *Acanthogryllus brunneri* (Saussure) from Tando Jam and adjoining areas, Sindh Province, Pakistan. The calling songs of this species were recorded and analyzed. Earlier, except us, this type of work has never been reported from this country. In this study it has been demonstrated that male calling song features possess important consistent information which can be very useful in taxonomic studies. The unique nature of stridulating sound patterns with its dominant frequency provides one of the most significant attributes for the recognition of males of *A. brunneri*. We also compared the analytical results of calling songs data of two other male specimens also identified as *A. brunneri* from Canary Island which suggested that the acoustic patterns appeared somewhat different from our presently locally described *A. brunneri*, the confirmation of identification of which was made by Prof. Dr. Libin Ma, Northeast Normal University, Chagchun, China as noted under the section, "materials and methods".

Keywords: Gryllids, A. brunneri, male calling songs, Geographical variation, systematics

INTRODUCTION

Gryllids in general are observed as important agricultural and household pests (Khan and Ahmad, 2013). Earlier, in Pakistan, like most foreign entomologists the individuals of Gryllidae family were recognized by their morphological characters along their male and female genital components (Kamaluddin *et al*., 2001). Allard (1910) for the first time recognized male calling songs of some cricket species from New England in late October. Fulton (1932) was the first systematist who used calling songs to differentiate cricket species.

He separated four different species in a group of sibling species possess different calling song patterns. Soon, acoustic communications were demonstrated to be used as an important biological character in crickets in aid to their taxonomy and Zoogeographical studies. (Hussain *et al*., 2017).

On a daily scale, the calling activity of *A. asiaticus* reached its peak between 9:00 PM and midnight, while on a seasonal scale, it peaked between March and May, corresponding to the summer months. The species emitted three distinct and stereotypical calls, consisting of courtship and post-copulatory calls, each comprised of two types of chirps.

Harp area was found to correlate with body size, and there was a important negative correlation between peak frequency and harp area and peak frequency could potentially serve as an indicator of body size in species (Kuriwada, 2023)..

Individuals of *Acanthogryllus asiaticus* Gorochov raised at higher temperatures exhibited mating calls characterized by faster speeds and higher peak frequencies in comparison to those raised at lower temperatures, indicating that developmental temperature influences mating call features (Singh, *et al*., 2020)

Crickets possess highly significant stridulating patterns, which is the most comprehensively understood apparatus for their systematics (Alexander, 1962). In some Grylloidea groups, male song plays a crucial role in distinguishing separate species that were formerly thought to be a single species (Gwynne and Morris, 1986).

Recent research has focused on verity in male signals among interspecific and intraspecific population, particularly their acoustic features, such as dominant frequency The frequency of calls can serve as a dependable and consistent isolating factor, particularly in investigations concerning the quality of male songs (Bentsen *et al*., 2006; Jennion and Petrie, 1997; Huber *et al*., 1989). This work was revised earlier research, demonstrated by Chopard (1938), which also highlighted the presented features.

MATERIALS AND METHODS

The authors and their colleagues had collected fifteen specimens from the Department of Zoology at University of Karachi and Sindh Agricultural University in Tando Jam, Pakistan primarily at night. The specimens were

gathered throughout April to September, coinciding with the summer season, when these gryllids produce sounds for intraspecific interaction. They were easily noticed and capture through handpicking technique from litter, under grass and close to the plant roots. Dr. Libin Ma from Northeast Normal University, Changchun, China, confirmed the identification of the specimens as *A. brunneri*.

The male call songs were recorded by using a Zoom H4 next handy recorder, and for further study and analysis of these songs, authors have used Audacity 1.3 for signal pre-conditioning as well as slicing the recorded songs into an appropriate length segment. Later, these segments were analyzed with the help of an open-source software package – Sound Ruler. The features extracted from the recordings of the call songs of 4 specimens of the species *A. brunneri* found in Tando Jam and adjacent localities in Sindh, Pakistan, have been noted in Table No. 1. Moreover, the table 1 also shows the parameters which the authors analysed from the male call recordings of two specimens from Canary Islands by the courtesy of Bioacoustica Repository also identified as *A. brunneri* on the web site www.bioacoustica.com.

RESULTS AND DISCUSSION

Acoustic features: (Figs. 1-6)

The temporal pattern as well as frequency spectrum of male calling songs of 4 specimens of *A. brunneri*, found near suburbs of Hyderabad, Tando Jam in Sindh, Pakistan, has been shown in the figures 1-4. The upper-left portion of all the figures show an oscillograph of stridulating song of the same species specimens revealing series of chirps in the time interval of 4 seconds. While the upper-right portion is the same sound pattern drawn at different time scale to reveal the internal structure of a chirp. The bottom-left part of the figures shows the spectrogram of the song while the bottom-right portion shows the power spectrum over the bandwidth of 4 kHz showing the dominant frequency of the song.

Cade and Otte (1982) studied the *Acanthogryllus* Chopard, genus by focusing on their alternating calling behavior and space patterns in the field. The authors detailed the chirp rate and analysed it with non-alternating males. Schmidt (1999) evaluated the species *A. acus* Gorochov but found that female specimens, lack the sound producing apparatus. In current studies, members of the genus *Acanthogryllus* were distinctly marked and isolated from all other Gryllidae genera. Their songs consisted solely of 2-3 groups of repeated chirps/ sec., with 11-14 pulses/ chirp and 22-28 pulses/sec. The genus also displayed a higher dominant frequency of 2.846-3.578 kHz, which showed the presence of long wings at the stridulatory teeth.

In the case of 4 specimens of *A. brunneri* found locally, i.e., in Tando Jam, Sindh, Pakistan (Figs. 1-4) we have noticed the chirp duration to be in the range of 0.292 -0.391 /sec. while the dominant frequency was in the range of 2.846 -3.014 kHz. Number of trills that we noticed in one of the recordings was 7/sec. the pulse duration in one specimen we noted was 0.28/sec.

The figures 5-6 show the call song structure of two specimens also identified as *A. brunneri* whose call songs were recorded somewhere in Canary Island. We have taken these sounds from the repository of Bioacoustica. Upon close examination of these two recordings, we found the chirp duration to be in the range of 0.499-0.512/ sec., while the dominant frequency was in the range of 3.416-3.578 kHz. The pulse duration was found to be in the range of 0.031-0.032/ sec. The number of trills per chirp were in the range of 15-16/ sec. The minor variations in the song features of two recordings from Canary Island do suggest that these recordings actually belong to two specimens of the same species.

If we compare these parameters with the ones found in Canary Islands recordings, we found differences in acoustic parameters among these recordings. For example, the chirp duration of local species from Tando Jam, Sindh, Pakistan is in the range of 0.292-0.391 /sec. while those found in Canary Island is in the range of 0.499-0.0.512/ sec. While the dominant frequency of local specimens is in the range of 2.864-3.014 kHz, whereas in the foreign recordings the dominant frequency was found in the range of 3.416-3.578 kHz. Similarly, the number of trills in the local (Pakistani) specimens is noted 7/ sec. as compared to 15-16/sec. in the recordings of foreign (Canary Island specimens). Our previous acoustic studies of *Acheta domesticus* (L.) suggested that there was only a minor variation in acoustic parameters among different conspecific specimens from different geographical regions (Hussain *et al.,* 2017).

Table 1. Acoustic features of *Acanthogryllus brunneri* specimens.

Features	Specimen-1	Specimen-2	Specimen-3	Specimen-4	Specimen-5	Specimen-6
Chirp Duration	0.292/ sec	0.338/ sec.	0.325 /sec	0.391 /sec	0.512/ sec	0.499/ sec
No. of Trills	N.A.	N.A.	N.A.	7/ Sec.	15/ Sec.	16/ Sec.
Dominant Frequency	2.915 kHz	3.014 kHz	3.014 kHz	2.846 kHz	3.578 kHz	3.416 kHz
Inter Chirp Interval	0.322 /sec	0.286/ sec	0.309 /sec	0.328 /sec	0.377 /sec	0.696/ sec.
Pulse Duration	N.A.	N.A.	N.A.	0.028/ sec	0.032/ sec	0.031/ sec.
Location	Tando Jam	Tando Jam	Tando Jam	Tando Jam	Canary Island	Canary Island

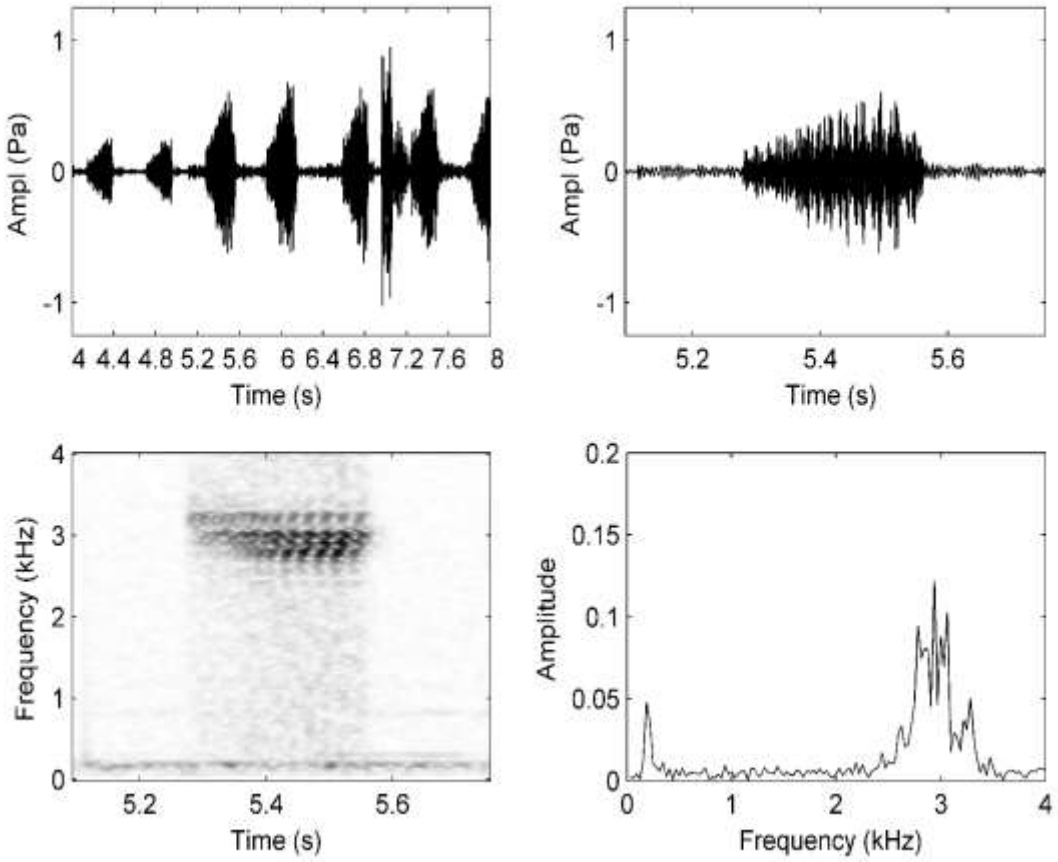

Fig. 1. Male call song features of *Acanthogryllus brunerri* (Specimen 1) found in Tando Jam. The upper two panels show the temporal structure of the song at two different time scales while the bottom two panels describe the spectrogram and the power spectra of the song.

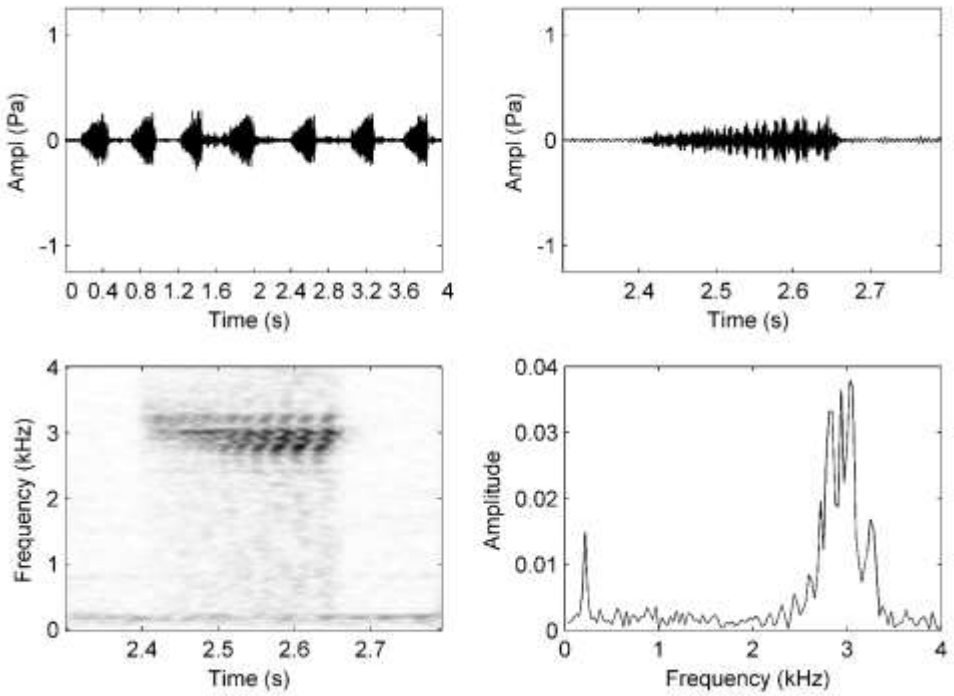

Fig. 2. Male call song features of *Acanthogryllus brunerri* (Specimen 2) found in Tando Jam. The upper two panels show the temporal structure of the song at two different time scales while the bottom two panels describe the spectrogram and the power spectra of the song.

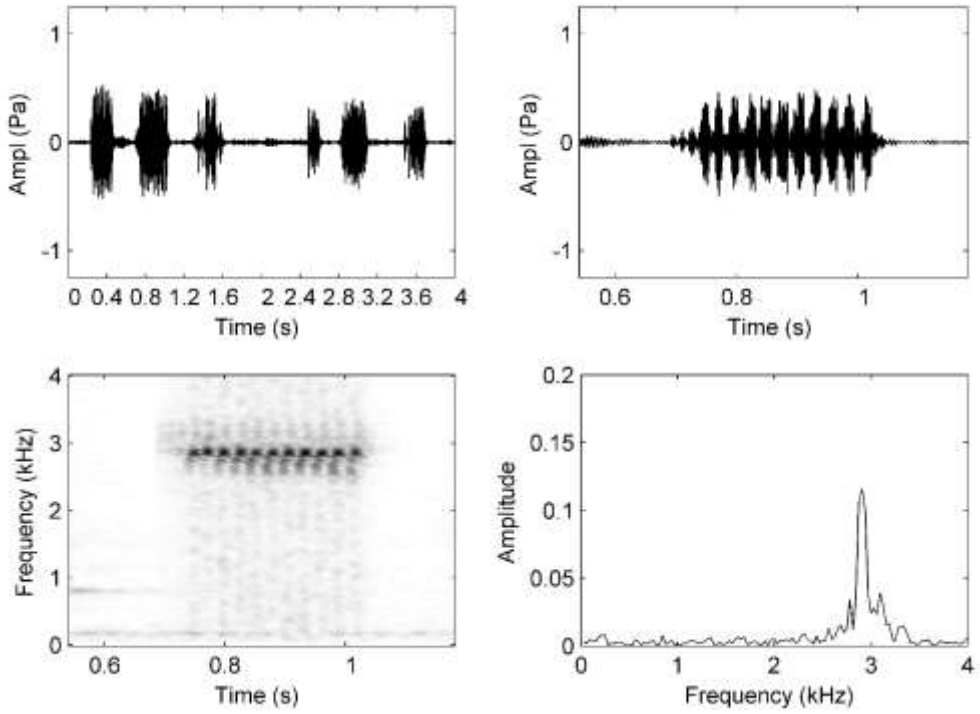

Fig. 3. Male call song features of *Acanthogryllus brunerri* (Specimen 3) found in Tando Jam. The upper two panels show the temporal structure of the song at two different time scales while the bottom two panels describe the spectrogram and the power spectra of the song.

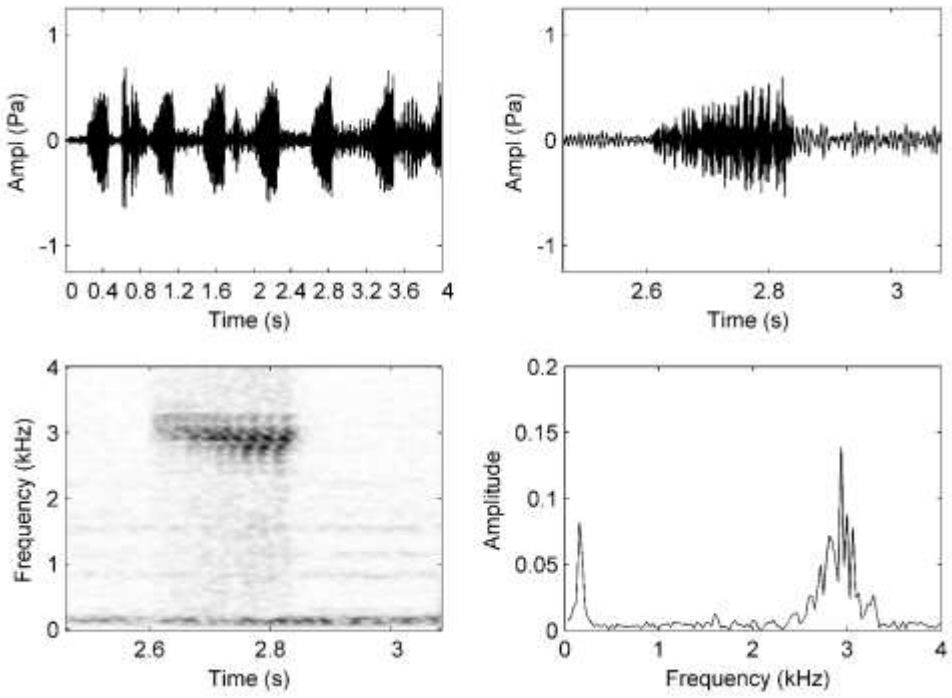

Fig. 4. Male call song features of *Acanthogryllus bunnerai* (Specimen 4) found in Tando Jam. The upper two panels show the temporal structure of the song at two different time scales while the bottom two panels describe the spectrogram and the power spectra of the song.

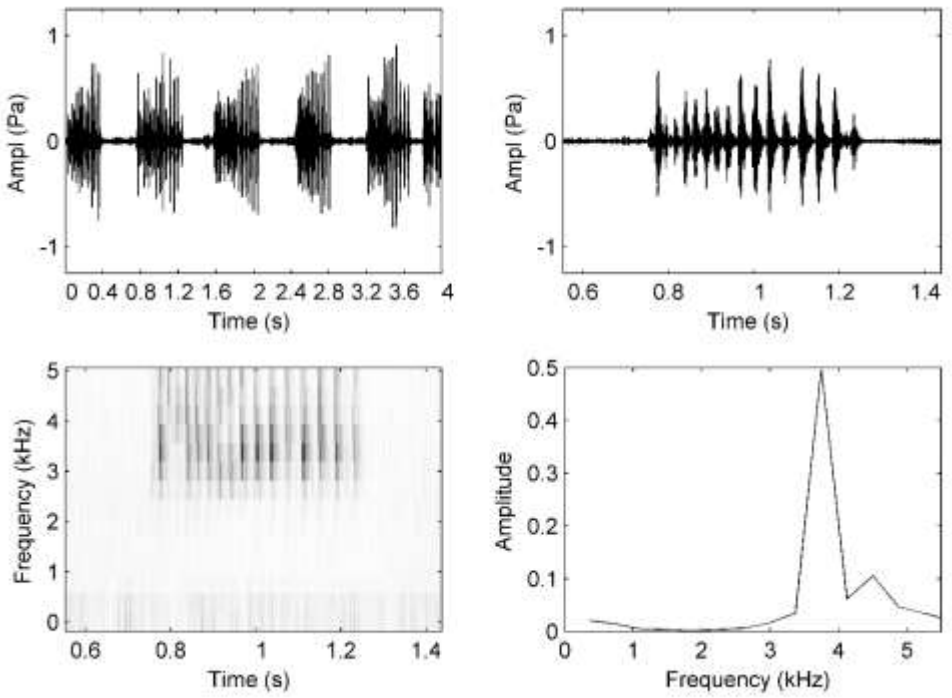

Fig.5. Male call song features of *Acanthogryllus brunerri* (Specimen 1) found in Canary Islands. The upper two panels show the temporal structure of the song at two different time scales while the bottom two panels describe the spectrogram and the power spectra of the song.

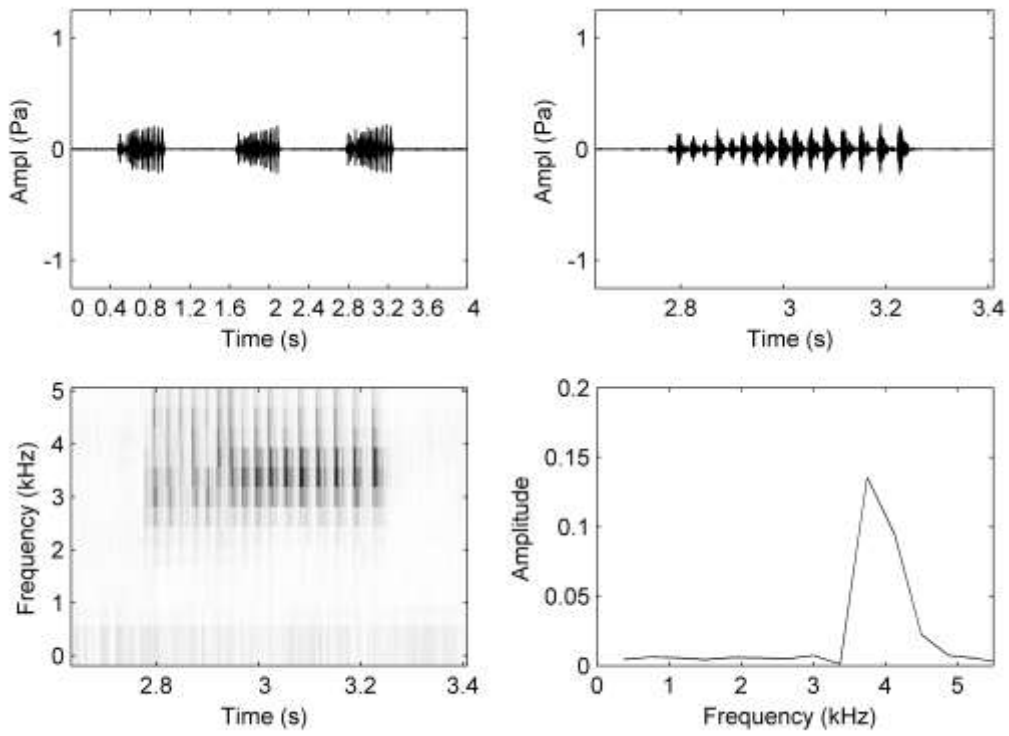

Fig. 6. Male call song features of *Acanthogryllus brunerri* (Specimen 6) found in Canary Islands. The upper two panels show the temporal structure of the song at two different time scales while the bottom two panels describe the spectrogram and the power spectra of the song.

Conclusion

Specimen No. 3-6 were collected from Tando Jam, Sind, Pakistan chirp duration 0.29 sec. -0.391 sec, pulse duration 0.028/sec., Inter chirp interval 0.286-0.328/sec., Number. of trills in each chirp 7 /sec. as compared to 15-16/sec. and dominant frequency 2.846-3.014kHz were observed.

Specimen No. 1 and 2 were collected from Canary Island were observed that they have chirp duration 0.499-0.512/sec., pulse duration 0.031-0.032/sec., Inter chirp interval 0.377-0.696/sec. No. of trills in each chirp 15-16 /sec. and dominant frequency 3.416-3.578 kHz.

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(*Accepted for publication May 2024*)