

# Mole Cricket (Orthoptera: Gryllotalpidae) Mating Calls: Characteristics in Recently Expanded Geographic Areas<sup>1</sup>

D.S. Reynolds<sup>2</sup>, L. Verburgt<sup>3</sup>, A.S. Schoeman<sup>4</sup>, and R.L. Brandenburg

Department of Entomology, North Carolina State University, Campus Box 761, Raleigh, North Carolina 27695, USA

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**Abstract** Mole crickets (Orthoptera: Gryllotalpidae) damage warm-season turfgrasses throughout the southeastern United States. The two most destructive species are the southern mole cricket, *Scapteriscus borellii* Giglio-Tos, and the tawny mole cricket, *S. vicinus* Scudder. Both species use mating calls to attract and locate potential mates. Male mating calls have often been used to distinguish among different species of crickets. Calling characteristics can vary within a species due to numerous factors, including climate. There has been no research conducted on the call characteristics of mole crickets as they have expanded their range of inhabitation to North Carolina. Male calls of southern and tawny mole crickets were recorded at night in 2009 and 2010. Analysis of the calls indicated that there was little change in the calling characteristics from previous research. This allows us to continue to expand our management plans for this pest and coordinate our efforts with other regions where mole crickets are located.

**Key Words** mole crickets, mating calls, call analysis, warm-season turfgrass

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Mole crickets (Orthoptera: Gryllotalpidae) cause economic damage to warm-season turfgrasses in North Carolina and throughout the southeastern United States. Two introduced species of mole crickets, *Scapteriscus borellii* Giglio-Tos, the southern mole cricket, and *S. vicinus* Scudder, the tawny mole cricket, are the most damaging. Calling songs of male crickets have been used extensively as a method for initial recognition of cricket species (Forrest 1983). Both *S. borellii* and *S. vicinus* have bell-like trills that vary in duration, intensity, carrier frequency, and pulse rate (Ulagaraj 1976). *Scapteriscus borellii* trills are often uninterrupted for a minute or more and have an average intensity of 68.5 dB, average carrier frequency of 2.62 kHz, and an average pulse rate of 54.7 pulses/s (Ulagaraj 1976). *Scapteriscus vicinus* trills often have brief pauses that occur several times each minute and have an average intensity of 65.4 dB, average carrier frequency of 3.2 kHz, and an average pulse rate of 135.9 pulses/s (Ulagaraj 1976). Species specificity was due to the differences in pulse rates and carrier frequencies between

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<sup>2</sup>Corresponding author (email: desilcox@ncsu.edu). Present address: Adama USA, 1306 Skyline Court, College Station, Texas 77845, USA.

<sup>3</sup>Department of Zoology and Entomology, University of Pretoria, Pretoria 0002, South Africa.

<sup>4</sup>Sports Turf Solutions, Pretoria, South Africa.

*S. borellii* and *S. vicinus* (Ulagaraj and Walker 1975). There have been no additional research efforts to examine the male calling characteristics of these two pests as their range has expanded over the past 30 yr and into their northernmost habitat to monitor any changes in ecology.

The intraspecific variation in call intensity and carrier frequency between species could be caused by the differences in the current environment, the previous environment, and the genetic factors of each individual (Ulagaraj 1976, Walker 1962). It is possible for male cricket calls to evolve over time. In mole crickets, trilling is the most common kind of signal and probably the ancestral condition; however, the prairie mole cricket, *Gryllotalpa major* Saussure, and the northern mole cricket, *Neocurtilla hexadactyl* Perty, exhibit a chirping call (Hoffart et al. 2002). This evolution from trilling to chirping could be a response to the environmental factors of these native North American species (Hoffart et al. 2002). North Carolina represents the northernmost habitat for *S. borellii* and *S. vicinus*. It is possible that the calls of these two species are different in North Carolina than from the populations in Florida. This research was conducted to determine the current male calling characteristics of North Carolina populations of these two mole cricket species. We evaluated each call for syllable duration, syllable period, intersyllable interval, carrier frequency, and bandwidth.

## Materials and Methods

Male mole cricket calls were recorded at Belvedere Country Club (Pender Co., Hampstead, NC) on 25 May 2009 and 27 May 2009. Previous soapy water flushes (Short and Koehler 1979) determined that 100% of the population was tawny mole crickets, *S. vicinus* Scudder. Mole crickets were also recorded at Olde Forte Golf Course (Brunswick Co., Winnabow, NC) on 3 June 2009. Previous soapy water flushes (Short and Koehler 1979) determined that 100% of the population was southern mole crickets, *S. borellii* Giglio-Tos. Twenty male calling songs for each species were recorded. The location for recordings was selected based on previous mole cricket population composition at that site.

Mole cricket calls were recorded at Scotch Meadows Country Club (Scotland Co., Laurinburg, NC) on 2 June 2010 and 9 June 2010. Previous soapy water flushes (Short and Koehler 1979) determined that 80% of the population was tawny mole crickets and 20% was southern mole crickets. Nineteen male calling songs of tawny mole crickets were recorded and two male calling songs of southern mole crickets were recorded. Calling crickets were flushed after recording; the location for recordings was selected based on previous mole cricket population composition at that site.

Calls both years were recorded with a Handy Recorder H4 (Zoom Corp., Tokyo, Japan) suspended 30 cm from the ground using nylon string tied to a MX 2000 tripod (OSN Corp., Stone Mountain, GA). The recorder was placed perpendicularly over the mole cricket calling chamber and the call was recorded for at least 30 s. Custom-designed software was used to analyze 15 randomly chosen consecutive syllables per recording, after initially filtering the recordings (high-pass filter = 1 kHz). The temporal characteristics measured were syllable duration, syllable period, and intersyllable interval for every syllable. In order to determine the start and end of

**Table 1. Comparison of five song characteristics between suggested species A (*Scapteriscus vicinus*) and suggested species B (*S. borellii*) in 2009.\***

| Song Trait                  | Species A<br>(n = 6)<br>(Mean ± SE) | Species B<br>(n = 38)<br>(Mean ± SE) | F      | P       |
|-----------------------------|-------------------------------------|--------------------------------------|--------|---------|
| Syllable duration (ms)      | 3.74 ± 0.45 b                       | 11.06 ± 1.71 a                       | 106.41 | <0.0001 |
| Syllable period (ms)        | 7.59 ± 0.4 b                        | 18.33 ± 0.92 a                       | 784.61 | <0.0001 |
| Intersyllable interval (ms) | 3.84 ± 0.47 b                       | 7.26 ± 1.23 a                        | 44.69  | <0.0001 |
| Carrier frequency (Hz)      | 3,165.35 ± 160.58 a                 | 2,801.58 ± 160.49 b                  | 27.8   | <0.0001 |
| Bandwidth @ -10dB (Hz)      | 509.83 ± 62.35 b                    | 256.76 ± 91.92 a                     | 50.83  | <0.0001 |

\* Values in the same row with the same letter are not significantly different (Tukey's mean separation test;  $P < 0.05$ ) for all tests,  $df = 42$ .

each syllable in an unbiased manner, it was necessary to initially determine the peak amplitude of the sound. The beginning of a syllable was then defined as the point when the amplitude of the syllable had increased to 20% of the peak amplitude. Similarly, the end of a syllable was defined as the point when the amplitude of the syllable decayed to 20% of the peak amplitude. Carrier frequency (analogous to emphasized or peak frequency) and frequency bandwidth at 10 dB below peak frequency were the spectral characteristics measured for each syllable and for the entire selection of 15 syllables per recording. Data were analyzed for differences in acoustic traits between species using one-way analysis of variance and means were separated using Tukey lines through the use of SAS version 9.1 (SAS Institute 2003).

## Results and Discussion

In 2009 there was a clear separation into two groups for the song traits. Arranging the recordings into two species groups according to the similarity of the syllable period and carrier frequency values measured yielded highly significant differences between these two groups for all five song traits (Table 1). In 2010 there were significant differences in all five acoustic traits measured between the two mole cricket species (Table 2).

We used syllable period and carrier frequency as the two traits used for species recognition with the 2009 data based on previous studies that have used these two characteristics to distinguish calls of different cricket species (Forrest 1983, Ulagaraj 1976, Ulagaraj and Walker 1973). The calling songs of *S. borellii* and *S.*

**Table 2. Comparison of five song characteristics between *Scapteriscus vicinus* and *S. borellii* in 2010.\***

| Song Trait                  | <i>S. vicinus</i><br>( <i>n</i> = 19)<br>(Mean $\pm$ SE) | <i>S. borellii</i><br>( <i>n</i> = 2)<br>(Mean $\pm$ SE) | <i>F</i> | <i>P</i> |
|-----------------------------|----------------------------------------------------------|----------------------------------------------------------|----------|----------|
| Syllable duration (ms)      | 3.46 $\pm$ 0.49 b                                        | 7.06 $\pm$ 4.41 a                                        | 16.8     | 0.0006   |
| Syllable period (ms)        | 6.85 $\pm$ 0.27 b                                        | 12.38 $\pm$ 7.24 a                                       | 19.57    | 0.0003   |
| Intersyllable interval (ms) | 3.39 $\pm$ 0.58 b                                        | 5.30 $\pm$ 2.50 a                                        | 10.13    | 0.0049   |
| Carrier frequency (Hz)      | 3,304.8 $\pm$ 204.8 a                                    | 2,338.5 $\pm$ 60.88 b                                    | 7.97     | 0.0109   |
| Bandwidth @ -10dB (Hz)      | 554.5 $\pm$ 63.05 a                                      | 426.6 $\pm$ 120.35 b                                     | 6.57     | 0.0190   |

\* Values in the same row with the same letter are not significantly different (Tukey's mean separation test;  $P < 0.05$ ) for all tests,  $df = 19$ .

*vicinus* recorded in North Carolina differ significantly from each other in all acoustic characteristics measured (Tables 1, 2). The characteristics measured from these species are similar to previous analyses of recordings in Florida over 30 yr ago (Ulagaraj 1976). This indicates that over time and a range expansion, the populations of *S. vicinus* and *S. borellii* in North Carolina are similar in calling characteristics to those populations in Florida. This allows us to continue to expand our management plans for this pest and coordinate our efforts with other regions where mole crickets are located.

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