

Oecanthus mhatreae sp. nov. (Gryllidae: Oecanthinae): A new species of tree cricket from Mexico, with an irregular song pattern and unique chirp-like trill configuration

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Abstract

A new species of *Oecanthus* is described from Mexico. *Oecanthus mhatreae* sp. nov. occurs in central Mexico in the understory of tropical deciduous forest. *Oecanthus mhatreae* sp. nov. is currently known only from the Corregidora area of the Mexican state of Querétaro. The widened tegmina and chirp-like brief trills song are consistent with some members of the *rileyi* species group; however, this new species of tree cricket is different in several aspects. The chirp-like brief trills are generally irregularly spaced, it does not have the expected grouping of the chirp pulses, and the colors of buff, light olive green, or light brown are vastly different than the four known pale green species in the *rileyi* species group of the Western Hemisphere. Morphology, habitat, and song details of this new species, with the common name of Otomi tree cricket, are provided in this paper. Video can be viewed at www.oecanthinae.com.

Keywords

Cimatario, Corregidora, Natasha Mhatre, new species, Otomí, Querétaro, tropical deciduous forest

Introduction

According to the current listing on the Orthoptera Species File online (Cigliano et al. 2019), there are eight genera of Oecanthinae worldwide, but only two occur in Mexico – *Oecanthus* and *Neoxabea*. The genus *Oecanthus* is comprised of 72 species, with ten of them occurring in Mexico (Walker 1967, Cigliano et al. 2019). Of the 23 species of *Oecanthus* in North America, Central America, and the Caribbean, 19 are divided into four main groups: *nigricornis*, *niveus*, *rileyi*, and *varicornis* (Walker 1967, Walker and Collins 2010, Walker 2019a). These groups can be distinguished by characteristics including: calling song character (chirping vs. trilling and continuous vs. intermittent); pulse or chirp rate at given temperatures; regular vs. irregular pattern of pulses or chirps; coloration of the antennae, head, pronotum, and abdomen; antennal markings on the pedicel and scape; and tegminal width.

Oecanthines in the *varicornis* and *nigricornis* species groups have prolonged trilling songs (Walker 1963, 1967), while the *niveus* species group males sing in intermittent bursts of trilling (Walker 1962). In the Western Hemisphere, only the *rileyi* species group tree crickets have highly regular chirping songs (Walker and Collins 2010).

Four chirping species in the *rileyi* species group of *Oecanthus* are currently known to occur in North America, Central America, and the West Indies: *O. alexanderi* Walker, 2010; *O. allardi* Walker & Gurney, 1967; *O. fultoni* Walker, 1962; and *O. rileyi* Baker, 1905. These four species have a chirping song with a grouping of pulses within each chirp, a pale green color with a white abdomen, and a round or oval mark on the pedicel and scape (Walker and Collins 2010).

In 1965, RD Alexander recorded songs of eight unknown chirping oecanthines in Mexico. TJ Walker analyzed the recordings (Walker and Collins 2010) and shared with NC that three songs had no pulse groupings in each chirp, questioning whether they might possibly be a new species group or clade. The chirp-like brief trills of this new tree cricket's song will be referred to as a chirping song for this paper.

A 2019 photograph (Fig. 1) accompanied by a sound recording posted on iNaturalist.org (2019) by IMCG and BVAG from the central Mexican state of Querétaro, led to the investigation of this new species. NC recognized the calling song as a long-trained chirping pattern, but the light brown color with a milky buff pronotum and light brown head was markedly different than other chirping species in North America.

Materials and methods

Habitat.—Specimens were found on private property of IMCG and BVAG in Fraccionamiento Vista Real, Corregidora, Querétaro, Mexico. The property is located adjacent to the Parque Nacional El Cimatario. The property sits on the southern slope of Cerro de Cimatario, an inactive volcano. The primary vegetation of this reserve has been characterized as deciduous tropical forest, cactus shrub, reforestation, and pasture (García-García et al. 2008). After

construction activities on the private property, the disturbed lands were recolonized by some ruderal species while other parts were planted with herbs and ornamentals.

BVAG monitored light intensity when the tree crickets were first heard singing over a five-day period. Light intensity measurements were used from online data in the Querétaro area (NWC 2019).

Collection methods.—Areas inhabited by tree crickets were determined both by manual searching and by locating actively singing males. Inhabited vegetation was then searched for adults of both sexes and nymphs. Specimens were collected in hand-held plastic containers. Photographs by BVAG, and sound recordings and specimen photographs by IMCG, were taken January–March 2019.

Measurements were made after the specimens were euthanized by freezing. Specimens were preserved in 70% alcohol until delivery to permanent depositories. Photographs were taken using a Samsung tablet and a Nikon D90 camera with a +4 Macro Close Up Neewer lens. Photographs, video, and sound recordings will be made available for viewing at Cigliano et al. (2019), iNaturalist (2019), and <http://www.oecanthinae.com>. The key from Walker (1967) was used for verifying the genus. Specimens were examined for the presence/absence of spines on the hind tibiae.

Acoustics.—Calling songs were recorded using recording app Grabadora Amazing MP3 with a Samsung tablet, with the tablet held as close to the singing tree cricket as possible. AVS4YOU Video Converter Software version 11.0 was used to convert MP4 to AVI. DoReMiSoft AVI to WAV Converter software was used to convert AVI files to WAV format. AVS4YOU Audio Editor Software version 6.1.2.375 and Raven Lite 2.0 were used to analyze the WAV sound tracks to make images of their waveforms and sound spectrums to measure the song frequency. Temperatures of the spots where tree crickets were singing were measured using a Taylor Sybron 5460 hand-held Mercury maximum minimum thermometer.

Morphological measurements.—The total body length refers to the midline length from the fastigium to the apex of the subgenital plate, not including antennae, tegmina, limbs, or cerci. The tegminal width was measured at the widest section, while resting atop the abdomen of the male. Pronotal length was measured along the medial line of the pronotum. The female's ovipositor was measured from its base at the distal abdomen to the tip. Photographs and measurements of the ovipositor, cerci, and metanotal gland, as well as counts of the stridulatory teeth, were made with the aid of a Jiusion Digital Microscope Model USB, magnification 40× to 1000×.

Results

Oecanthus mhatreae Collins & Coronado, sp. nov.

<http://zoobank.org/A2D3D82F-C1A6-43BD-B795-FFFB2FA652E2>

Etymology.—Specific epithet in honor of Natasha Mhatre, who has worked extensively with Oecanthinae and has published many articles focusing on acoustic communication. The pronunciation of mhatreae is MAT-ray-ee [MAT] [rā] [-ee]. The common name, Otomi tree cricket, is after the Otomí, an indigenous people of Mexico inhabiting the central Mexican Plateau region.

Type verification.—The genus *Oecanthus* was determined by the presence of spines on the hind tibiae.

Type material.—MEXICO, holotype ♂, alcohol vial, Querétaro, Corregidora, Fraccionamiento Vista Real, 20° 52' 20" N, 100° 38' 80" W; elevation ca 2130 m, understory of tropical deciduous forest, I. Coronado leg., 24 Jan 2019, deposited at Universidad Nacional Autónoma de México (UNAM), Mexico City.

Paratypes: 1 ♀ and 1 ♂, 23–24 January 2019, and 1 ♀ and 1 ♂ 13 February 2019, same location as holotype, deposited at UNAM.

Male holotype description and measurements.—(in mm). Light olive green wings with dark staining along some veins. Pronotum milky buff color. Grayish tan head with four lighter streaks running to pronotum, and light pink patch near scapes. Pedicel and scape pale green. Antennae pale greenish white. Eye color purplish. Palpi translucent tan. Oval black mark on each pedicel and scape. Abdomen light olive green with scattered darker blotches. Femurs translucent olive green; tibiae and tarsi light olive green. Body length 13.5; tegminal length 13.7; tegminal width 6.8; pronotal length 2.2; distal pronotal width 2.4; hind femur length 10; cerci 4.9. The stridulatory file length is 1.5 mm, and the stridulatory teeth count is 36.

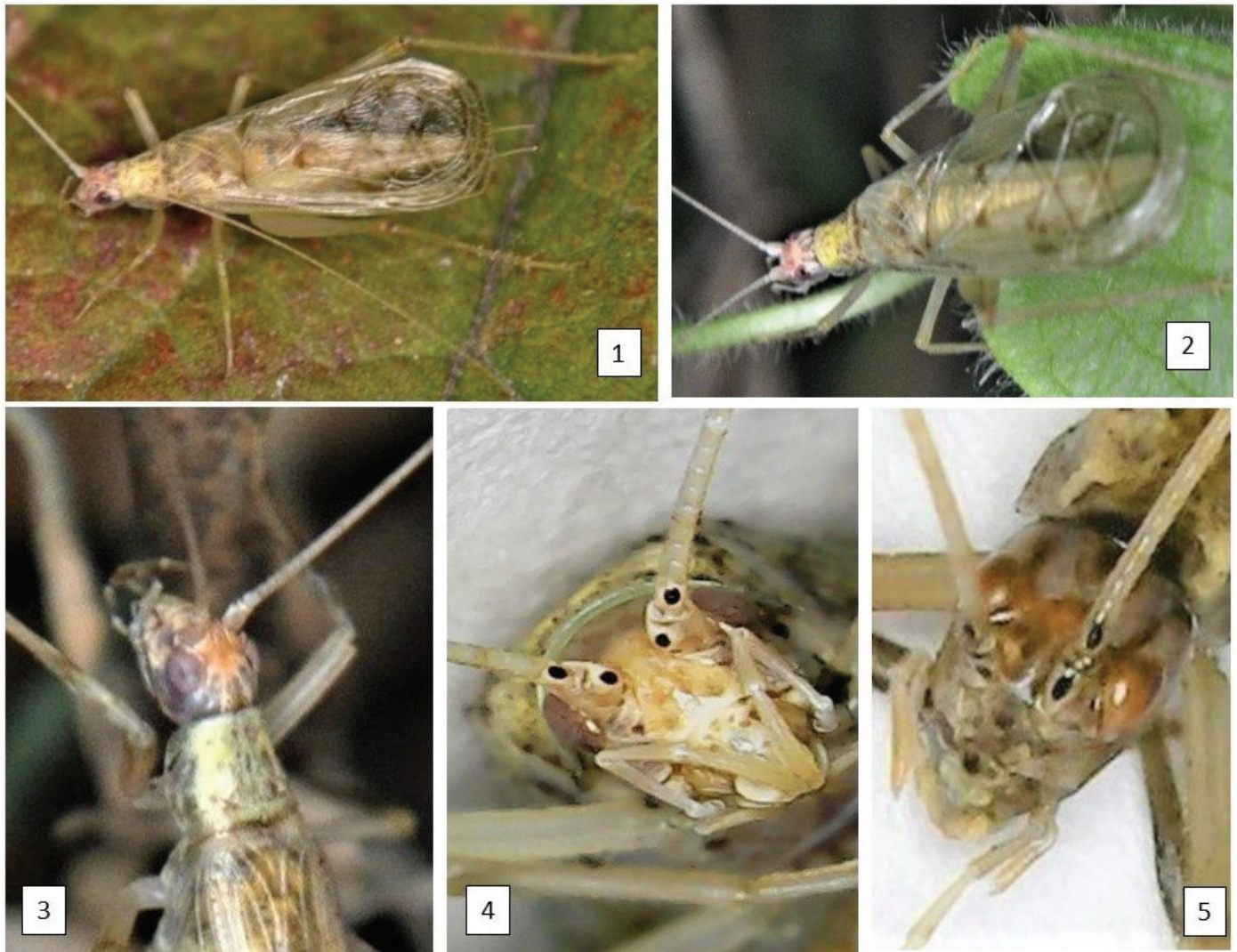
Characters.—Overall color of both sexes can range from light brown (Fig. 1) to light olive green (Fig. 2). Tegmina with dark staining along veins. Head grayish or brownish with small patch ranging from pink to peach. All individuals have four lighter colored vertical streaks on the distal portion of the top of the head extending to under the pronotal shield (Fig. 3). The light brown individuals are not believed to be a true brown form of this species as the pronotum is equally buff colored to the pronotum on the olive green individuals. The patch of color on the head is located even with and just behind the scape. Pedicel and scape colors vary from whitish to greenish to brownish. Ventral surface of pedicel and scape each with one oval black mark (Figs 4, 5). The black mark is situated on a whitish field; however, dead specimens darken and the white may not be readily visible.

Antennae filaments translucent greyish white or tan. Eye color purple to brown. Palpi translucent tan. Pronotum has a milky or creamy buff or light olive color (Figs 1–3, 6). Tympanal membrane on fore tibiae whitish. Ventral abdomen with scattered, slightly darker blotches and speckles; color varies from light olive, buff or tan (Fig. 7). Tarsi light olive or light brown, tibiae olive or tan, femora translucent light olive green or tan. Some individuals with whitish area at ventral femoral-tibial joints. Cerci straight and pale, extending beyond the distal edge of the tegmina. Hind wings do not extend beyond distal edge of tegmina. The metanotal gland photo (Fig. 8) was taken of a dead specimen, and this species darkens from freezing euthanasia. Right tegmen stridulatory file as in Fig. 9 with 32–36 teeth; file length 1.4–1.7 mm.

Paratype males measurements: Body length 12.4–13.0; wing length 11.0–12.0; wing width 5.8–6.9; pronotal length 1.5–2.8; distal pronotal width 2.0; hind femur length 7.0–8.2; cerci length 4.3–5.0.

Paratype female measurements: Female with matching antennal markings and coloring as males. Body length 12.5–12.8; wing length 11.5–12.0; wing width 3.0–3.1; pronotal length 1.9–2.5; distal pronotal width 1.8–2.0; hind femur length 7.5–8.8; cerci length 6.5–6.6; ovipositor length 6.25–6.5. Ovipositor extends slightly beyond the tips of the cerci (Fig. 10).

Nymphs as in photos of 3rd–5th instars (Figs 11–13).



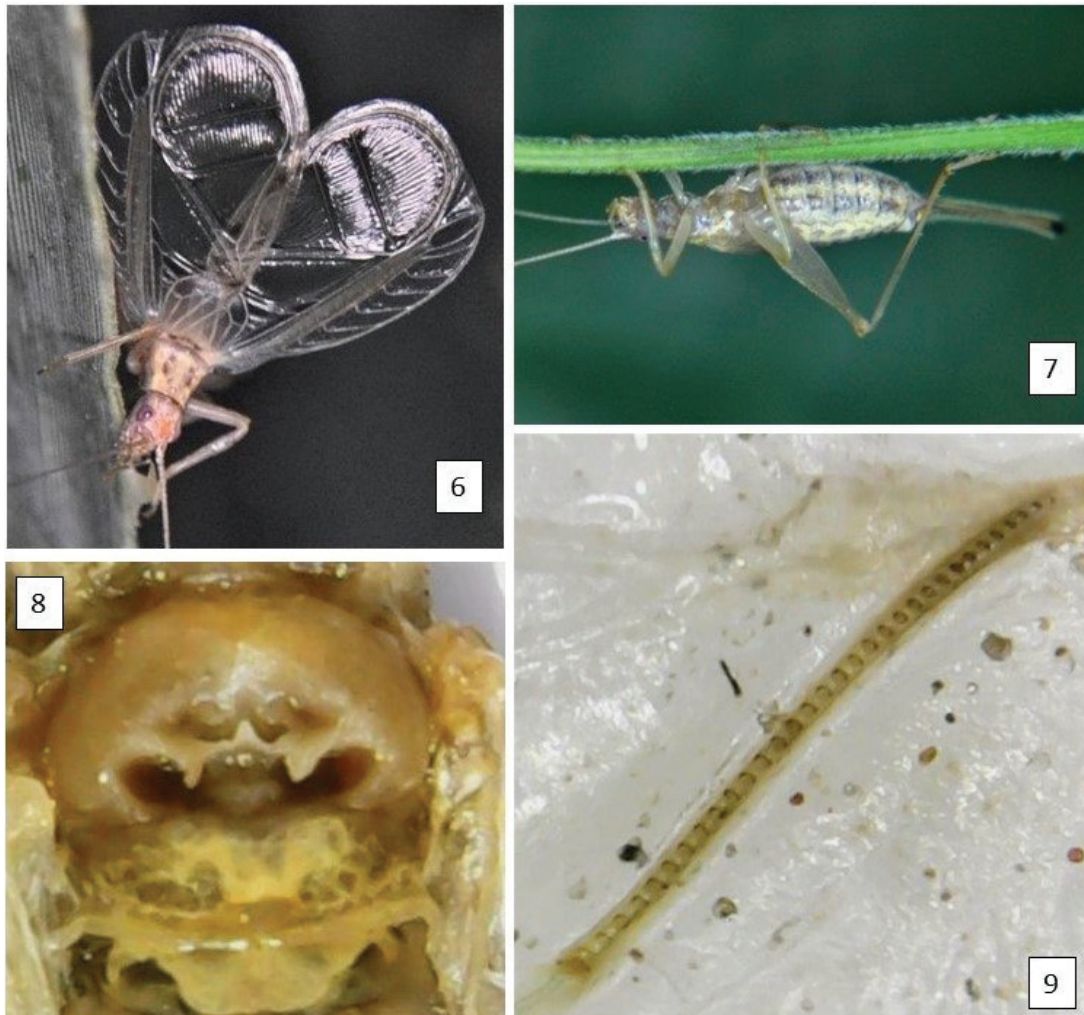
Figs 1–5. *Oecanthus mhatreae* sp. nov.: 1. Light brown male. 2. Light olive tone male. 3. Adult female head and pronotum. 4. Antennal markings on holotype male. 5. Antennal markings on paratype female.

Habitat.—Tree crickets were found on ten plant species: *Anisacanthus pumilis* (F. Dietr.) Nees; *Cnidoscolus multilobus* (Pax) I. M. Johnston; *Colubrina triflora* Brogn. Ex Sweet; *Croton ciliatoglandulifer* Ortega; *Dasilyrion parryanum* Trel; *Iresine cassiniiformis* S. Schauer; *Justicia candicans* Nees L D Benson; *Ruta graveolens* L; *Senecio salignus* DC.; and *Thunbergia alata* Bojer ex Sims (Martínez and Sandoval 2017). Of these plants, *R. graveolens*, *C. multilobus*, and *T. alata* are introduced species. The only plants Otomi tree crickets were witnessed as actively feeding upon were *C. ciliatoglandulifer*, a native plant, and on *C. multilobus* and *T. alata*, which, unlike the native vegetation, are evergreen plants (Calderón de Rzedowski and Rzedowski 2001).

Climate.—According to records on the National Water Commission website, rainfall totals for Querétaro were (listed in mm from January 2018 through March 2019): 9.2, 10.0, 2.8, 24.1, 39.5, 161.8, 31.4, 71.7, 110.2, 58.6, 31.1, 3.8, 7.5, 2.3, and 4.6. The lowest temperatures occurred in January 2018 (5.3°C in 2018 and 8.5°C in 2019). The warmest temperatures from January–March 2019 were 24.7°C, 28.1°C, and 29.6°C.

Behavior.—Light intensity readings ranged from less than 5 W/m² to 12 W/m² at the time males began singing. Song monitoring in January and February revealed Otomi tree crickets began singing from one minute before to eleven minutes after sunset and were singing within 10 minutes of sunset in temperatures of 17–18°C and past midnight in temperatures less than 12°C. The holotype male and one paratype female were video recorded mating while in captivity. A video clip can be viewed at www.oecanthinae.com.

Calling song.—The song pattern and chirp configuration of Otomi tree cricket were instrumental in diagnosing this new Mexican oecanthine. Waveform analysis showed that each chirp was comprised of a long string of pulses with no groupings (Figs 14–16). The recordings taken in the field and in captivity by IMCG were at temperatures of 14°C–19°C. The carrier frequency of the calling song at 17°C was slightly above 2.6 kHz (Fig. 17). One recording revealed the intermittent long chirp song of interest with a faster chirping species in the background (Fig. 18). The faster chirping was 3–4 times faster than the long chirping of this new species, affirming the slow rate of the target species while the highly regu-



Figs 6–9. *Oecanthus mhatreae* sp. nov.: 6. Singing male showing buffy pronotum (on native plant *Dasylirion parryanum* Trel.). 7. Adult female showing blotching on ventral abdomen. 8. Metanotal gland. 9. Stridulatory file and teeth.

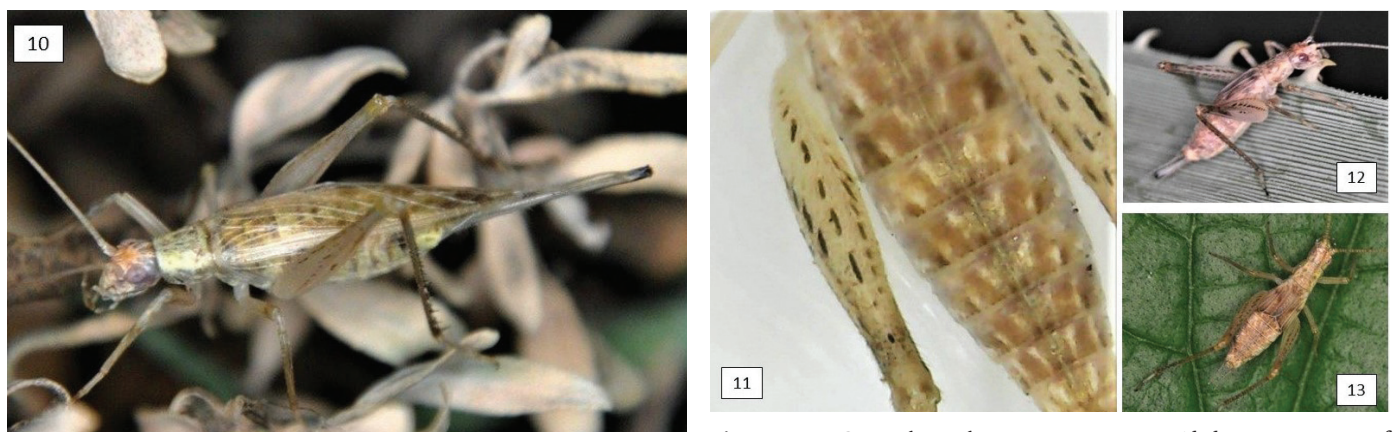


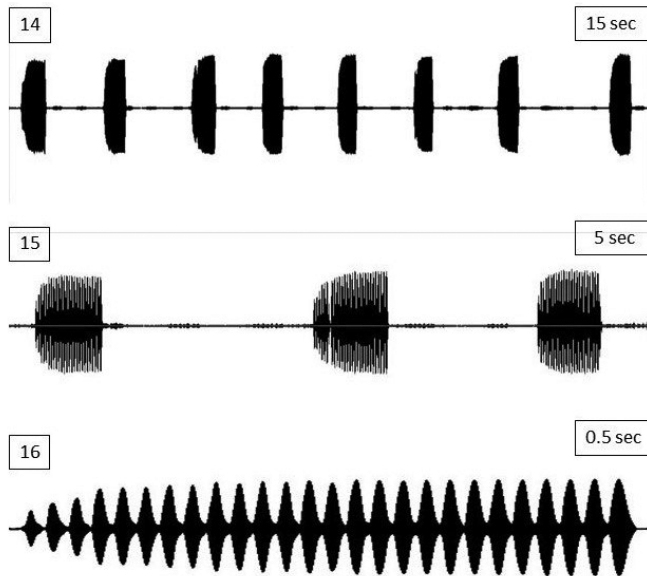
Fig. 10. Adult female coloring and ovipositor length (on non-native *Ruta graveolens* L.).

Figs 11–13. *Oecanthus mhatreae* sp. nov.: 11. Abdomen pattern of 3rd instar nymph. 12. Female 4th or 5th instar nymph. 13. Male 4th or 5th instar nymph.

lar spacing of the background singer affirmed the irregular pattern of Otomi tree cricket. The irregular chirping pattern and the ungrouped chirp configuration of this new species were compared to the patterns and configurations of four other chirping species, two intermittent trilling species, and one continuous trilling spe-

cies (Fig. 19). The four chirping species in the *rileyi* species group display grouping of their pulses.

Oecanthus varicornis, from the *varicornis* species group, has continuous trilling with runs of pulses over several seconds, while *O. mhatreae* sp. nov. chirps never exceed 0.7 second. Of the three



Figs 14–16. Waveforms of the calling song of *O. mhatreae* sp. nov. at 17°C: 14. Chirping for 15 seconds. 15. Three chirps. 16. A single chirp (0.5 sec duration) with 26 ungrouped pulses.

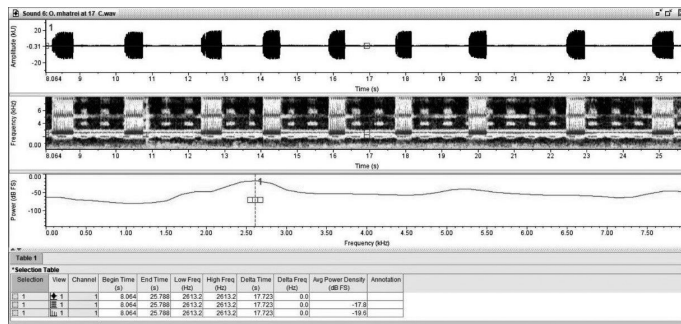


Fig. 17. Audio recording of the calling song of *O. mhatreae* sp. nov. at 17°C showing a carrier frequency of slightly above 2.6 kHz.

intermittent bursts of trilling species, *O. niveus* has a J-shaped mark on the scape (Walker 1962). The second species, *O. exclamatoris*, has markings on the pedicel and scape that resemble an inverted exclamation mark (Fulton 1915). The third intermittent bursts of trilling species, *O. leptogrammus*, does have an irregular pattern similar to *O. mhatreae* sp. nov.; however, the coloring and antennal markings are markedly different for these two species. *Oecanthus leptogrammus* is very pale green (Collins et al. 2014) and has a thin black line on each pedicel and scape (Walker 1962).

At all temperatures, the chirping pattern of Otomi tree cricket was irregular. This sporadic rate and pattern were unlike any of the other known chirping species in North America. Fig. 20 shows the irregular rate at a variety of temperatures and includes a sample of the early evening warm up song heard most evenings. Since Otomi tree cricket has an irregular chirping pattern, a trend line graph cannot reliably be used for comparison with chirpers with regular patterns. The chirp rate at recorded temperatures was plotted for comparison to the other known songs (Walker 2019b, Cornell Lab 2019) of North American chirping species (Fig. 21, Table 1). The graph displays the general niche that each of these five species occupy.

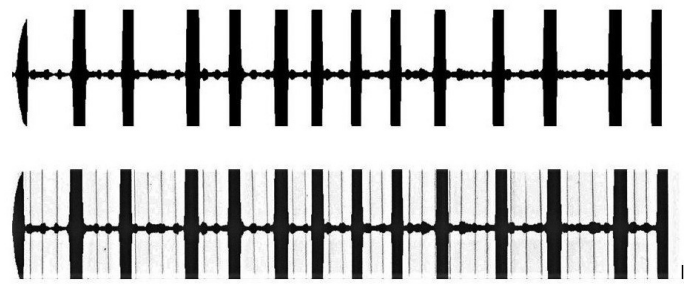


Fig. 18. Calling song recording of *O. mhatreae* sp. nov. at 17°C. The clip was amplified to highlight the background song. This 30-sec clip shows the irregularly spaced *O. mhatreae* sp. nov. chirps at a rate of 28 pulses per minute with a yet to be determined chirping species in the background with a highly regular pattern at a rate of 100 chirps per minute.

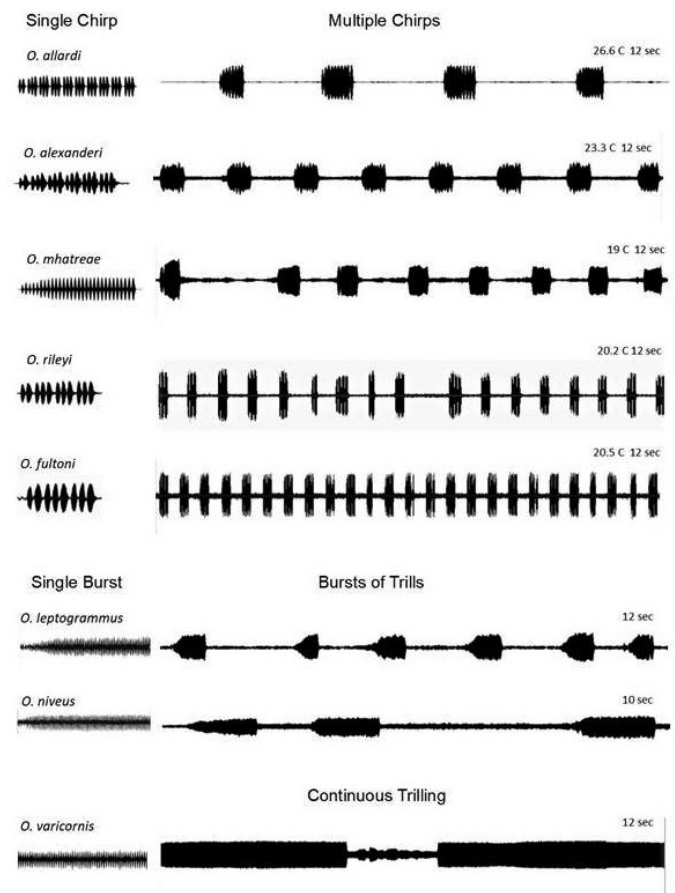


Fig. 19. Comparisons of song patterns, single chirps and single bursts of trilling. *O. mhatreae* sp. nov. recorded in Querétaro. All remaining recordings in library of NC. *Oecanthus leptogrammus* and *O. allardi* recorded in Nicaragua; remaining species recorded in the United States.

Diagnosis.—Characters that separate *O. mhatreae* sp. nov. from other chirping species of tree crickets in the *rileyi* species group include: 1) an overall darker coloring than the usual very pale green; 2) dark speckles and blotches on the abdomen; 3) dark staining along veins of the tegmina; 4) milky buff or olive color of the pro-

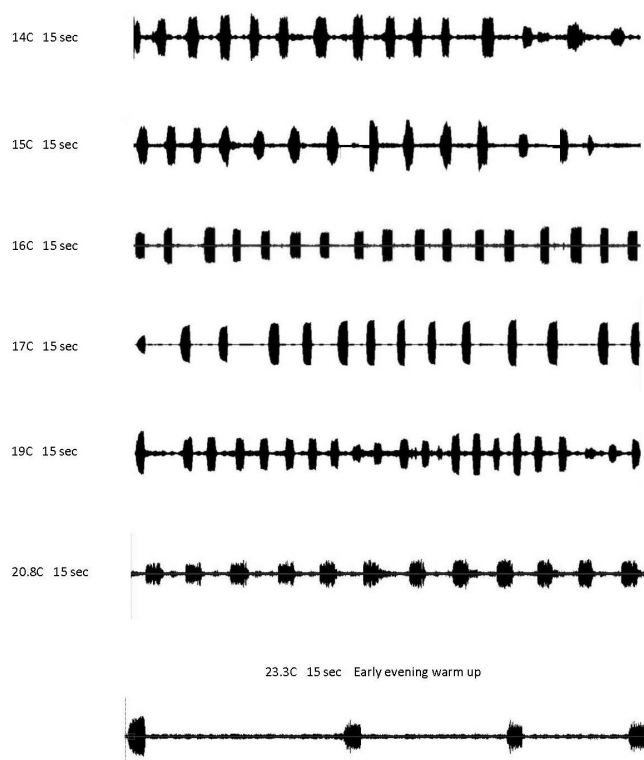


Fig. 20. *Oecanthus mhatreae* sp. nov. males chirping in various temperatures.

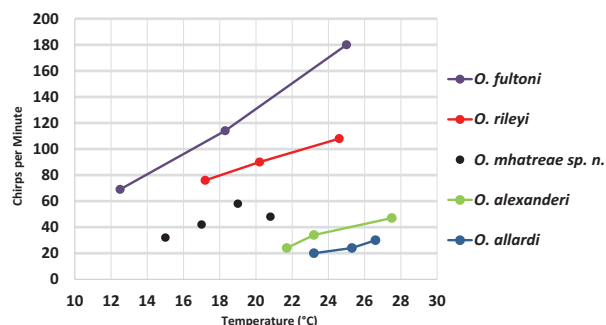


Fig. 21. Graph comparing chirps per minute at given temperatures.

Table 1. Data and sources of chirps per minute at recorded temperatures of *O. mhatreae* sp. nov. and other chirping species of *Oecanthus* in North America. Source recordings: SINA – Singing Insects of North America; ML – Macaulay Library; recordings in library of NC; and new recordings for this paper from Querétaro.

Species	Temp C	Ch/min	Source
<i>O. fultoni</i>	12.5	69	SINA 585slo
	18.3	114	SINA 585slj
	25	180	ML 124884
<i>O. rileyi</i>	17.2	76	ML 124705
	20.2	90	ML 124791
	24.6	108	SINA 588sl
<i>O. mhatreae</i> sp. nov.	15	32	IC and BG Querétaro
	17	42	
	19	58	
	20.8	48	
<i>O. alexanderi</i>	21.7	24	NC Texas USA
	23.2	34	
	27.5	47	
<i>O. allardi</i>	23.2	20	ML 114499
	25.3	24	ML 125543
	26.6	30	NC Nicaragua

notum; 5) no grouping of the pulses in individual chirps; and 6) an irregular chirping pattern.

Fourteen species of *Oecanthus* found in the Western Hemisphere are not associated with an established species group and not all have recordings of songs available online. Otomi tree cricket's stridulatory teeth count, antennal markings, and song type were compared to those fourteen species, but no matches were found (Table 2).

Discussion

We describe this new species of *Oecanthus* but cannot place it in one of the species groups for Western Hemisphere tree crickets. Although by ear this new species sounds similar to *O. alexanderi* and *O. allardi*, it can be distinguished by the irregular chirping pattern and by the analysis of the configuration of each chirp due to the absence of grouping of pulses. Both *O. alexanderi* and *O. allardi* group the pulses within a single chirp into a 2, 3, 3... pattern (Walker and Collins 2010). *Oecanthus mhatreae* sp. nov., however, has 17–30 pulses in a chirp with no grouping of the pulses.

Table 2. Comparison of characters for 14 other species of *Oecanthus* found south of the United States that are not currently placed in a species group. Gray fields indicate the characters that do not match those of Otomi tree cricket.

<i>Oecanthus</i> Species	Stridulatory Teeth Total	Pedicle Mark	Scape Mark	Song Type	Source Providing Details
<i>mhatreae</i> sp. nov.	32–36	Oval	Oval	Irregular pattern; long chirps	
<i>comma</i>	44	Comma	Teardrop		Walker 1967
<i>immaculatus</i>	24	No marking	No marking		Bruner 1906; Walker 1967
<i>jamaicensis</i>	27–29	Post	Post	Continuous trilling	Walker 1969
<i>lineolatus</i>	48	Line	Line	Regular trilling chirps	Saussure et al. 1897; Walker 1967
<i>major</i>	34	No marking	Line		Walker 1967
<i>minutus</i>	37–45	No marking	Line or no marking		Walker 1967
<i>nanus</i>	51–54	No marking	No marking		Walker 1967
<i>pallidus</i>	32	Line	Line	Long regular chirps	Zefa et al. 2012
<i>peruvianus</i>	35	No marking	No marking		Walker 1967
<i>pictipes</i>	50–53	L-shape and dot	Line and dot		Rehn 1917; Walker 1967
<i>pictus</i>	47	L-shape	Thick vertical mark	Continuous trilling	Milach et al. 2015
<i>prolatus</i>	28	Oval	Thin post		Walker 1967
<i>tenuis</i>	44	Bowed line	Line		Walker 1967
<i>valensis</i>	38–46	Line	Line		Milach et al. 2016

Since the songs of *O. mhatreae* sp. nov. and *O. leptogrammus* are similar in chirp-like trill durations and both species occur in Mexico, care should be taken when trying to identify these species by sound. Although there are limited recordings of *O. leptogrammus*, it has a raspy sound, whereas *O. mhatreae* sp. nov. has a flute-like sound. It would be interesting to compare the song of *O. mhatreae* sp. nov. with that of *O. comma*. The song of *O. comma* is currently unknown. Of the remaining 14 species of *Oecanthus* not associated with a species group, *O. comma* seems the most likely to have the potential of being grouped with *O. mhatreae* sp. nov., as the antennal markings of *O. comma* are not linear, and it was described as occurring in Mexico.

While Otomi tree cricket is currently known only from Querétaro, Mexico, more investigation is needed to understand its full geographic range, elevations of occurrence, and types of habitat. More exploration is needed throughout Mexico for other undescribed species heard by RD Alexander over 50 years ago.

We encourage others to post submissions of observations to iNaturalist, as we believe there are other new species waiting to be discovered by specialists reviewing photographs and/or sound recordings on this worldwide public website. There are many non-entomologists and citizen scientists eager to provide data for investigations of insects in their locations.

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