

Oecanthus texensis: A new species of tree cricket from the western United States

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Abstract

This article describes and names a new species of *Oecanthus* Serville, 1831 from the western United States. *Oecanthus texensis* n. sp. Symes & Collins is currently known from southern Oklahoma, Texas, southern Arizona, and southwestern Idaho. Habitats include desert, prairie, weedy fields, and woody secondary growth. *O. texensis* has been collected in oak, walnut, pinyon pine, and mesquite, as well as a variety of landscaping hedges and shrubs. The *Oecanthus* genus contains four clusters of species. The tegmina shape, song structure, and antennal markings suggest that *O. texensis* falls within the *varicornis* group. The structure of the call is similar to the other members of the *varicornis* species group, but the pulse rate is unique. Song analysis shows that at 25°C, *O. texensis* produces a continuous trill with approximately 41 pulses per second and a dominant frequency of 3.8 kHz, making it the slowest pulsing member of the *varicornis* group.

Key words

Gryllidae, Oecanthinae, *varicornis* group

Introduction

The genus *Oecanthus* currently contains 64 species (Eades *et al.* 2013). In North America, there are four main *Oecanthus* species groups: *nigricornis*, *niveus*, *rileyi* and *varicornis* (Walker 1962a; Walker 1963; Walker & Collins 2010). These groups can be distinguished by characteristics including: song type (chirping *vs* trilling and continuous *vs* interrupted); tegminal morphology; coloration of the head, pronotum, and abdomen; antennae color; and antennal markings on the pedicel and scape. Three species in the *varicornis* group are known to occur in the United States: *O. varicornis*, *O. californicus* and *O. latipennis*. We present a description of a previously-unnamed fourth species in the *varicornis* group.

Although this species has not been named or formally described, it has been recognized and collected for over fifty years. Images, sound recordings, and other natural history information have been available on the Singing Insects of North America (SINA) website since 2001 (Walker & Moore 2013). A formal description will facilitate the process of establishing the range of this species, identifying photographs and recordings, and referencing the species in biodiversity surveys and research publications.

Materials and methods

The species group was determined using the Key to Species Groups of *Oecanthus* located on the SINA site (Walker & Moore 2013). Specimens were pinned, preserved in alcohol, or dried for later DNA analysis using anhydrous calcium sulfate crystals. Specimens are held at three depositories: the Florida State Collection of Arthropods, Gainesville, FL, USA (FSCA), the University of Wisconsin, Madison, WI, USA (UW), and the California Academy of Sciences, San Francisco, CA, USA (CAS).

Morphological measurements.—Detailed morphological measurements were obtained by dissecting specimens and affixing the pronotum, tegmina, femur, and tibia to a transparency sheet, scanning the sheet on a flatbed scanner, and measuring it using the program ImageJ (Rasband 2012). Pronotal length was measured along the medial line of the pronotum. The tegminal width was measured at the widest point. Tegminal length was measured from the base of the tegmen to the most distant point. The antennal markings found on the ventral surface of the pedicel and scape were photographed using a Canon PowerShot S5 IS digital camera. To determine the number of teeth in the stridulatory file, we photographed the tegmina under a dissecting scope and counted the teeth from the image.

Song and temperature recordings.—Songs from crickets collected in Laredo, TX, USA were recorded using a Canon PowerShot S5 IS digital camera set in video mode at 30 frames/sec, with the camera held 10-50 cm from the singing cricket. The sound track had a sample rate of 44100 Hz with a 16-bit sample size. An avi-to-wav converter marketed online by 008soft.com was used to extract the sound track from the video file. AVS4YOU Audio Editor Software version 4.2 was used to analyze the sound tracks and to make images of their waveforms. The temperature was measured within 15 cm of actively singing males using a hand-held digital thermometer manufactured by LaCrosse Technology, model WS-9029U. Accuracy of the digital thermometer was confirmed by using a water bath and comparing its readings with a precision glass laboratory thermometer.

Crickets from the Tarrant County, TX area were recorded by placing individual males under screen tents and then recording them using a Marantz 661 solid state recorder at 96 kHz and 24 bit depth. The recorder was connected to a Sennheiser ME 62 microphone with a K6 power module housed in a 43.2 cm (17") Telinga parabolic dish. Recordings were analyzed using Raven Pro Version 1.4 (produced by the Cornell Lab of Ornithology). Pulse rate was calculated by using the interactive detector feature to detect and number individual pulses. Temperature was measured using a CEM DT-172 temperature logger.

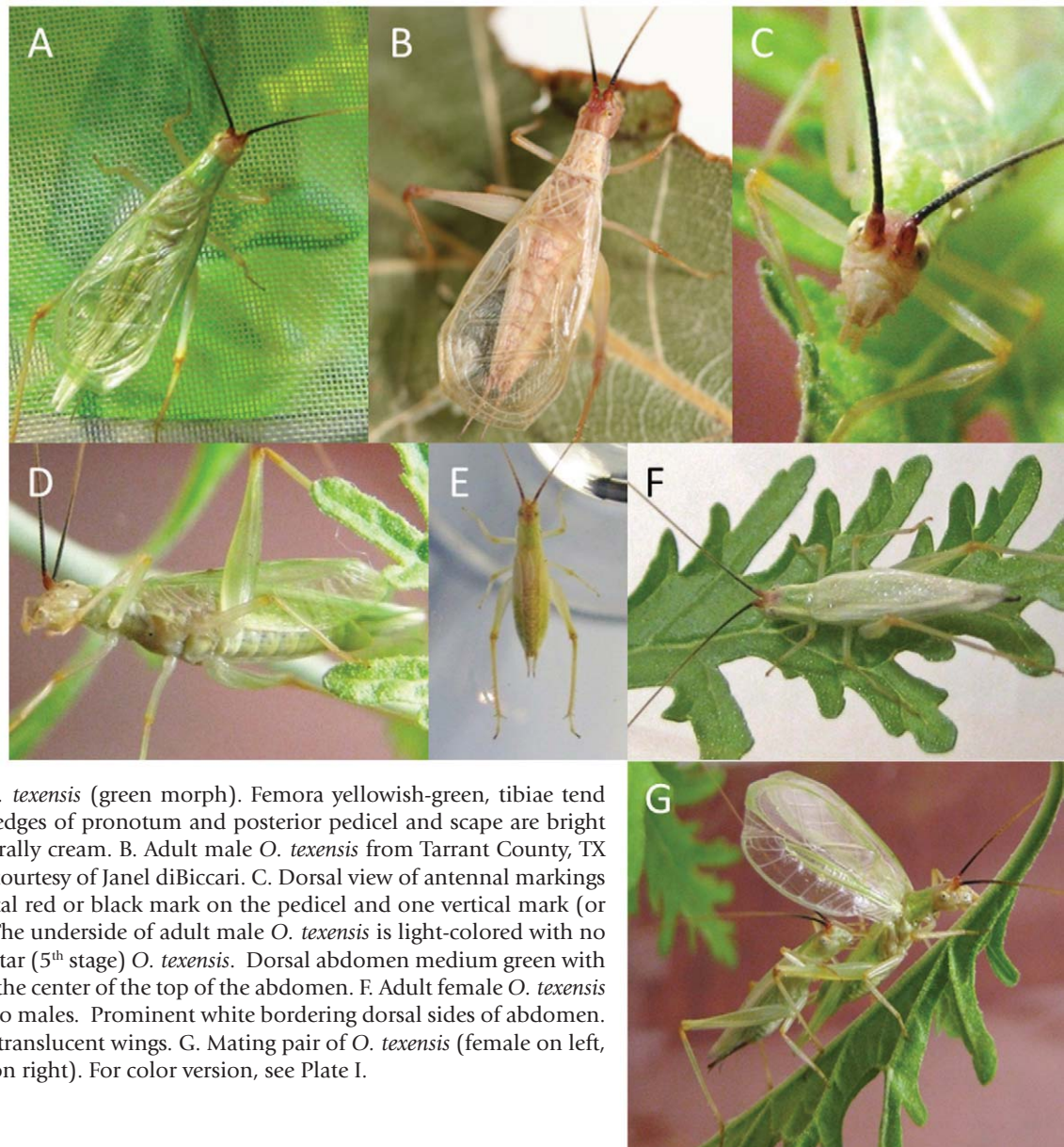


Fig. 1. A. Adult male *O. texensis* (green morph). Femora yellowish-green, tibiae tend to be dark gray. Lateral edges of pronotum and posterior pedicel and scape are bright white, and eyes are generally cream. B. Adult male *O. texensis* from Tarrant County, TX (brown morph). Photo courtesy of Janel diBiccari. C. Dorsal view of antennal markings of *O. texensis*. One vertical red or black mark on the pedicel and one vertical mark (or none) on the scape. D. The underside of adult male *O. texensis* is light-colored with no visible patterning. E. Instar (5th stage) *O. texensis*. Dorsal abdomen medium green with pale rose running down the center of the top of the abdomen. F. Adult female *O. texensis* (green morph). Similar to males. Prominent white bordering dorsal sides of abdomen. Latticed vein pattern on translucent wings. G. Mating pair of *O. texensis* (female on left, male with raised wings on right). For color version, see Plate I.

Results

Oecanthus texensis Symes & Collins n. sp.

Holotype.—Green morph male. Keller, TX. June 29, 2011, N 32.9287°, W 97.2285°, L. Symes. Deposited in the FSCA.

Paratypes.—Same data as type (1♂ brown morph) UW, (1♂ brown morph) CAS

Morphological measurements.—In the *O. texensis* population in Tarrant County, TX, the mean pronotal length was 0.17 ± 0.03 cm. The mean tegminal length was 0.93 ± 0.05 cm with a width of 0.73 ± 0.04 cm. The front femur was 0.27 ± 0.02 cm. The rear femur was 0.65 ± 0.04 cm and the rear tibia was 0.71 ± 0.04 cm. In Tarrant County, TX, *O. texensis* had a mean of 46 teeth in the wing file (10th percentile: 44 teeth, 90th percentile: 50 teeth). In the same sites, *O. varicornis* had a mean of 31 teeth (10th percentile: 26 teeth, 90th percentile: 33 teeth), allowing differentiation of these otherwise nearly identical species.

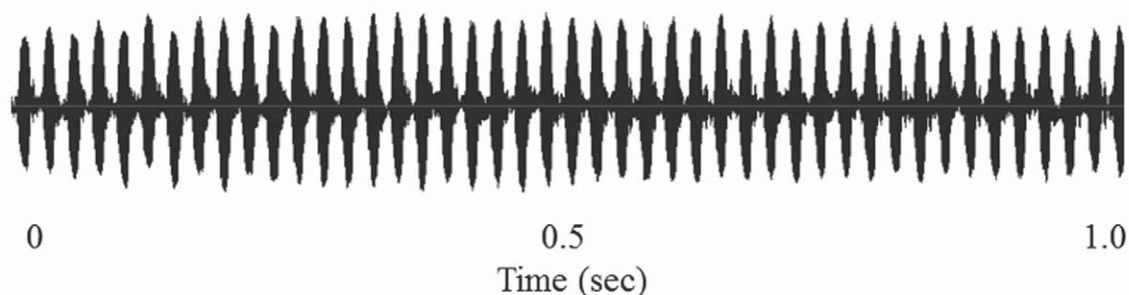
Color.—Two color morphs were collected in Tarrant County, TX [green (N=5) and brown (N=13)].

Green morph: Overall color of both sexes pastel green, generally with beige on the head/face (Fig. 1A, B). Patch of dark rose on head near antennae. Eye color generally cream. Palpi pale beige. Pedicel may show black marks (Fig. 1C). Pronotal area pastel green. Ventral abdomen pale cream (Fig. 1D). Antennae filaments black at proximal end, becoming brown distally. Tympana on fore tibiae colorless. Tarsi grey, tibiae and femora pale green with yellow tint. Yellow-gold at femoral-tibial joints. Cerci pale and long (extending to the tip of the ovipositor in the female).

Male. Fore wings (tegmina) pale yellowish-green and paddle shaped; approximately twice as wide as width of abdomen. Hind wings extend just beyond distal edge of tegmina. Inner area of metanotal gland appears pale beige; outer rim appears pale green.

Female. Similar coloration to male. Latticed vein pattern on translucent wings (Fig. 1F).

Fig. 2. Waveform of 1 second of trill from *O. texensis* at 25.7°C.



Juvenile: Dorsal abdomen yellowish-green with patterned dusky rose strip running from the head to the distal tip of the abdomen (Fig. 1E).

Brown morph: Morphologically similar to the green morph (Fig. 1B). Overall color pale tan to nearly colorless. Full head and pronotum a dark reddish-brown. Eyes cream. Ventral abdomen cream to tan. Leg joints darker in color, approaching a deep brown, while legs lighter in color.

Song.—Males were heard calling primarily at night. Around dusk, males sometimes produced short bursts of calling, but then extended to continuous calling. Males called from partially concealed locations in trees and shrubs, often hanging on the edge or underside of leaves. *O. texensis* produce a continuous trill with 41 pulses per second at 25.0°C (Fig. 2). The dominant frequency of the song is approximately 3.8 kHz at 25.0°C. Like other members of the *Oecanthus* genus, pulse rate varies linearly with temperature (Walker 1962a, 1963) (Fig. 3). Frequency usually varies linearly or slightly reduces its rate of increase at higher temperatures (Walker 1962a, 1963). At a given temperature, the pulse rate of *O. texensis* is slower than any member of the *varicornis* group (Fig. 4). Photographs, videos, and recordings will be made available at OSF, Macaulay Library (catalog numbers fall between 185800 and 186109), SINA (Walker & Moore 2013), and at www.oecanthinae.com.

Diagnosis.—According to the current listing on The Orthoptera Species File (OSF), there are nine genera of Oecanthinae worldwide, but only two occur in the U.S. and Mexico – *Oecanthus* and *Neoxabea*. The genus of *Oecanthus* was confirmed by the presence of spines on the hind tibiae, and the lack of a tubercle on the distal border of

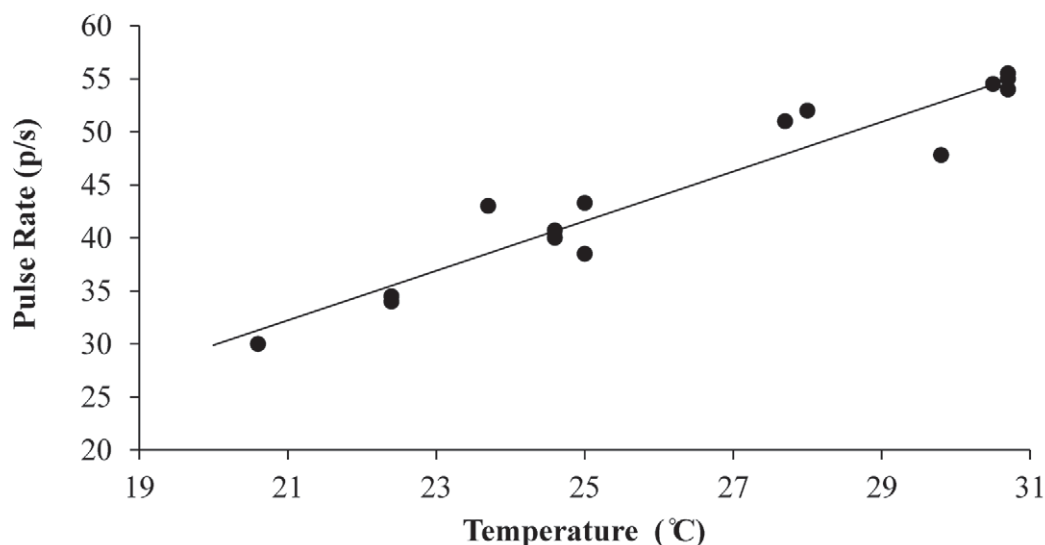
the scape (Walker 1967). Members of the *varicornis* group have a continuous trilling song, wide tegmina, and often have two marks on the scape and pedicel. For comparison, members of the *nigricornis* group of *Oecanthus* have a continuous trilling song, narrow tegmina, and three or four black marks on the scape and pedicel. The *niveus* group has intermittent bursts of trilling, narrow tegmina, and two black marks on the scape and pedicel. The *rileyi* group has regularly spaced chirps, wide tegmina, and two black marks on slightly raised ivory/white fields on the scape and pedicel.

Several characteristics are informative for identifying species of *Oecanthus*:

- Color, shape, and intensity of patches of color on the head and apex of the head (Fig. 1A, B).
- Presence or absence of markings on the front of the first and second antennal segments (the scape and the pedicel) (Fig. 1C).
- The color(s) and patterning of the ventral abdomen (Fig. 1D).
- Tegminal size, shape and occasionally notable vein pattern differences (Fig. 1A, B, G).
- Number of teeth on the file – located in the lower region of the male's right tegmen (wing).
- Number of pulses per second in the male song at a given temperature (Figs 3, 4).

Distribution.—Specimens of *O. texensis* have been found in the western United States in the states of Oklahoma, Arizona, Idaho, and Texas (Fig. 5). Insects were collected in a variety of habitats: desert, prairie, weedy fields, young secondary forest, and in land-

Fig. 3. *O. texensis* pulse rate changes linearly with temperature. Pulse rate (pulses/sec) = $2.3 * ^\circ\text{C} - 16.9$. Recordings from Tarrant County, TX. These and other data are available in the Supporting Materials.



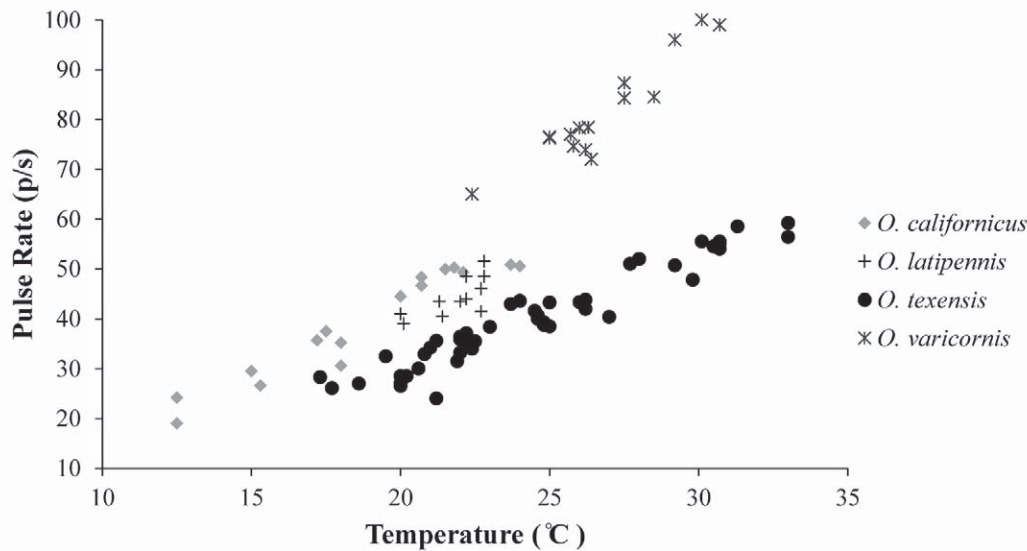


Fig. 4. *O. texensis* has a slower pulse rate than the other members of the *varicornis* species group found in Texas. *O. californicus* sample values are taken from Walker (1963). *O. latipennis* data are previously unpublished. *O. varicornis* sample values include previously unpublished data and data from Walker (1963). Although the pulse rates of *O. californicus* and *O. latipennis* are similar to each other, these species do not co-occur together.

scaped areas. Within these habitats, *O. texensis* occupied diverse plants including walnut (*Juglans* spp.), pinyon pine (*Pinus edulis*), mesquite (*Prosopis* spp.), Osage orange (*Maclura pomifera*), young oaks (*Quercus* spp.), and greenbriar (*Smilax bona-nox*) as well as several other unidentified small trees and shrubs.

The species was first documented in 1959 in Palo County, Texas, USA by Thomas J. Walker (TJW) (see map, Fig. 5). Subsequently, TJW documented the species in Oklahoma and Arizona. Additional specimens were collected in Laredo, TX, by NC and LS in 2009 and NC in 2010. In 2010-2012, LS collected *O. texensis* in Tarrant County, TX, near Fort Worth, TX. In 2012, specimens matching the morphological and acoustic description of *O. texensis* were collected in Boise, ID, by LS and Robin Costello.

Adult males have been found from May through September. In Laredo, TX, collection dates were May 2009 (NC and LS) and June 2010 (NC). In Tarrant County, TX, adult males were found throughout the sampling period of May to August. Detailed collection data including habitat, county, state and date are found in the Supporting Materials. Data for specimens collected by TJW can also be found on the SINA website (Walker & Moore 2013).

Discussion

Oecanthus texensis, a previously undescribed member of the *varicornis* group, is morphologically and acoustically differentiated from other previously-described species. The broad tegmina and continuous call suggest placement in the *varicornis* group, and the high tooth count and slow pulse rate differentiate this species from other known members of the group. In at least some parts of its range (Tarrant County, TX), *O. texensis* has two co-occurring color morphs (green and brown). Although some amount of geographic variation in color is quite common in *Oecanthus*, color polymorphisms within a site are known in only a few species. However, habitat coloration in the Fort Worth, TX, site was quite heterogeneous, both spatially and temporally, with the vegetation often changing from green to brown over the course of adult activity. Depending on the environment, either or both morphs could be quite cryptic, suggesting that the polymorphism may be maintained by variation in the environment or may be stabilized by negative frequency-dependent selection from visually-orienting predators.

For the green morph, coloration may provide additional in-

formation to help differentiate *O. texensis* from the co-occurring species *O. varicornis*. Coloration differences include: 1) A salmon-colored patch on the head of *O. texensis*, and a dark red-colored patch on *O. varicornis*, and 2) Pale yellowish-green tegmina on *O. texensis*, and bright green tegmina on *O. varicornis*. Despite careful examination, the brown forms of these two species appear visually indistinguishable except for differences in the number of teeth on the right tegmen. Although the coloration of *O. texensis* has similarities to some *O. californicus* individuals, the tooth count and pulse rates are non-overlapping and separate these two species.

O. texensis has been documented in several locations and a variety of habitats in the south central United States. Many other areas of the western United States have similar climate and vegetation, suggesting that this species may be found in uncensused areas. Although the characteristics of the Boise, ID population are consistent with other populations of *O. texensis*, broader geographic sampling is needed to ensure that the Boise population falls within the range of *O. texensis* and is not another undescribed species or recent introduction of *O. texensis*. The presence of *O. texensis* in sites near the US-Mexico border suggests that the complete range of *O. texensis* extends into Mexico and possibly into Central America as well. Although *O. texensis* was relatively abundant in the locations sampled, little is known about the full extent of its range, habitat usage, or ecological interactions.

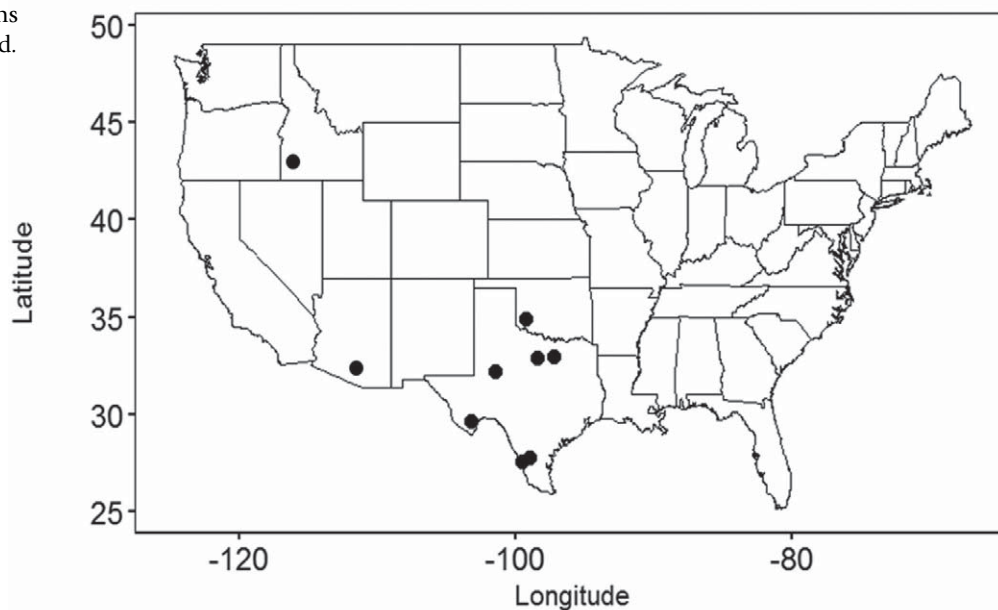
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References

- Eades D.C., Otte D., Cigliano M.M., Braun H. 2013. Orthoptera Species File Online. Version 2.0/4.1. <http://orthoptera.speciesfile.org/>
- Fulton B.B. 1915. The tree crickets of New York: life history and bionomics. N. Y. Agricultural Experimental Station. Technical Bulletin 42: 3-47.

Fig. 5. Black dots show locations where *O. texensis* has been collected.



Rasband W.S., ImageJ, U. S. National Institutes of Health, Bethesda, Maryland, USA, 1997-2012. <http://imagej.nih.gov/ij/>

Walker T.J. 1962a. The taxonomy and calling songs of United States tree crickets (Orthoptera: Gryllidae: Oecanthinae). I. The genus *Neoxabea* and the *niveus* and *varicornis* groups of the genus *Oecanthus*. *Annals of the Entomological Society of America* 55: 303-322.

Walker T.J. 1962b. Factors responsible for intraspecific variation in the calling songs of crickets. *Evolution* 16: 407-428.

Walker T.J. 1963. The taxonomy and calling songs of United States tree crickets (Orthoptera: Gryllidae: Oecanthinae). II. The *nigricornis* group of the genus *Oecanthus*. *Annals of the Entomological Society of America* 56: 772-789.

Walker T.J. 1967. Revision of the Oecanthinae (Orthoptera: Gryllidae) of America South of the United States. *Annals of the Entomological Society of America* 60: 784-796.

Walker T.J., Collins N.J. 2010. New world thermometer crickets: the *Oecanthus rileyi* species group and a new species from North America. *Journal of Orthoptera Research* 19: 371-376.

Walker T.J. 2012. Key to Species Groups of *Oecanthus*. Singing insects of North America: crickets and katydids. <http://entnemdept.ifas.ufl.edu/walker/buzz/g576k.htm>

Walker T.J., Moore T.E. 2013. Singing insects of North America. <http://entnemdept.ifas.ufl.edu/walker/Buzz/>

Supporting material.—Spreadsheet containing call characteristics and collection localities for *varicornis* group species: *O. texensis*, *O. californicus*, *O. latipennis*, and *O. varicornis*, can be found on BioOne, (<http://www.bioone.org/loi/orth>), this issue.