

Neoxabea mexicana sp. nov. (Gryllidae: Oecanthinae): A new species from Mexico and a key for *Neoxabea* in North and Central America

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Abstract

A new species of tree cricket, *Neoxabea mexicana* sp. nov., is described from northeast Mexico. Although it has morphological similarities to two other species found in Mexico, there are distinguishing characters, such as a well-developed tubercle on the pedicel, black markings on the maxillary palpi, one of the two pairs of spots on the female wings positioned at the base of the wings, stridulatory teeth count, and the pulse rate of the male calling song. The calling song description and pre-singing stuttering frequencies are provided. Character comparisons that rule out other species in the genus are presented. The common name given to this new species is Mexican tree cricket. Sound recordings and video are available online. We also make some clarification of the status of *Neoxabea formosa* (Walker, 1869), described as *Oecanthus formosus*, and present a key of *Neoxabea* in North and Central America.

Keywords

Acoustics, key, Nuevo Leon, Orthoptera, pedicel tubercle

Introduction

A photograph posted in October 2018 (Fig. 1) on Naturalista (2020) of a female tree cricket in northeast Mexico led to the investigation of the new species described here. According to the current listing on the Orthoptera Species File (OSF) online (Cigliano et al. 2020), only two of the thirteen species of *Neoxabea* have been documented in Mexico—*N. bipunctata* (De Geer, 1773) and *N. formosa* (Walker, 1869). A 2020 photograph (Naturalista 2020, iNaturalist 2020) from Bosques del Rey, Guadalupe, Nuevo Leon, Mexico, showed a male tree cricket that lacked spines on the hind tibiae and had areas of dark staining on the tegmina. Subsequent findings of another male and female (Figs 2, 3) from the exact locality as the photograph of the female in 2018 led to further photographs, song recordings, and the collection of specimens. By ear, the recordings (Naturalista 2020, iNaturalist 2020) revealed the same slow clicking sound sometimes made by other species in this genus, but the trilling portion of the song had a richer musical quality than the buzzy sound of *N. bipunctata*.

The morphology and song data of *N. bipunctata* are well documented and thus easily compared to this new species. The lack of data for *N. formosa*, along with its complicated history, presented challenges. In his description of *Oecanthus formosus* Walker, 1869, a female specimen from the collection of M. Salle was designated as the holotype (Walker 1869). In the preface of F. Walker's description, J.E. Gray (Keeper of Zoology, which then included entomology) explained that letters before any specimen "denote the specimens now contained in the British Museum," and F. Walker listed the specimen as "a – Mexico. From M. Salle's collection."

Kirby (1906) catalogued much of the Insect Collection in the British Museum (Natural History), and listed *O. formosus* as a synonym of *N. bipunctata*, adding ** to indicate that the type was present in the collection. In his 1966 examinations of *Oecanthinae*, T. Walker indicated that the *N. formosa* holotype was missing from the British Museum. The British Museum, at Great Russell Street, London, originally included both human and natural history collections, but in 1881 the Natural History Department was transferred to a new building in South Kensington and referred to as the British Museum (Natural History). In 1963, this was legally separated from the British Museum, though it retained the name BM(NH) until 1992, when it was formally renamed as the Natural History Museum (NHM), referred to more recently in publications as NHMUK.

In November 2020, after requesting confirmation from NHMUK that the type specimen of *Oecanthus formosus* was missing, as cited in the OSF website (Cigliano et al. 2020), Ben Price, Senior Curator at the NHMUK, located the holotype of *O. formosus*. The number on the specimen "[18]56–143" refers to the Accession Register and confirms the data of this specimen as "From Mexico. Purchased from Cuming. Collected by M. Sallé on & around the volcano of Orizaba." Orizaba is located in Veracruz, Mexico. T. Walker (1967) noted a female specimen with a label of "type ?" from the British Museum and wrote that if any question is associated with the specimen being a type, it should not be designated as such. He also pointed out that the female might eventually prove to be other than *N. formosa*. He indicated that there were two species present among the specimens regarded as

N. bipunctata, and that the females of *N. formosa* could not be distinguished from those of *N. bipunctata*.

Thirteen specimens from Mexico and Brownsville, Texas, were examined by T. Walker in four major collections (Walker 1967). He determined that males have 56–63 stridulatory teeth and included that data on a graph with several other species of *Neoxabea* (Walker 1967). The Florida State Collection of Arthropods (FSCA) holds five specimens labeled as *N. formosa* (Fig. 6A–E), including two male and three female specimens from “Brownsville, Texas, USA” and “Atoyac, Veracruz, Mexico”. The specimen presented in Figure 6A has tubercles on both the pedicel and scape and a dark line on the palpi. The three female specimens, faded from age (Fig. 6C–E), have a single spot mid wing on each side and a fainter pair of spots at the base of the wings.

A photograph taken by NC in September 2019 (Fig. 7A, B) shows two of the six specimens held in the collection at the Academy of Natural Sciences in Philadelphia labeled as *N. formosa*. Figure 7A represents a female collected in Brownsville, Texas, and Figure 7B a female collected in Veracruz, Mexico. The Veracruz specimen has two pairs of spots that are centrally positioned, and the Brownsville specimen has one of the two pairs of spots positioned at the base of the wings.

This paper describes a new species of *Neoxabea* that has a stridulatory teeth count that falls within the range of some of the male specimens labeled as *N. formosa* that T. Walker examined in 1966. The original species of *N. formosa* remains intact, with the only known specimen being the holotype, a female, at the NHMUK in South Kensington, and which was collected at the volcano Orizaba in Veracruz, Mexico (Fig. 17E). A key for five species of *Neoxabea* known to occur in North and Central America is provided.

Materials and methods

Collection methods.—Individuals were found on an outdoor illuminated ceiling and walls.

Type verification.—Keys from Walker (1967) and the Singing Insects of North America (SINA) (2020) were used to verify the genus. Specimens were examined for the absence of spines on the hind tibiae.

Song recordings and analyses.—Songs of an actively roaming captive male were recorded using a Huawei P30 Pro cellphone held as close to the singing tree cricket as possible. The cellphone was tested for calibration by recording a file from SINA and comparing the pulse rate and frequency to the original file. Raven Lite 2.0 was used to prepare waveforms to count pulse rates, and spectrograms were used to determine carrier frequency.

Habitat.—Individuals were found on the private property of CGV-M in Guadalupe, Monterrey, Nuevo Leon, in northeast Mexico. Native vegetation on the property includes *Tecoma stans* (L.) Juss. ex Kunth; *Senna alata* (L.) Roxb.; *Asclepias curassavica* L.; *Lantana camara* L.; *Poliomintha bustamanta* B. L. Turner; *Croton ciliatoglandulifer* Ortega; *Ruellia simplex* C. Wright; *Merremia dissecta* (Jacq.) Hallier f. (POWO 2020).

Guadalupe sits at the base of Cerro de La Silla, and the private property sits approximately 800 meters from the start of vegetation of the mountain. Species of vegetation that predominate on the mountain are *Vachellia rigidula* (Benth.) Seigler & Ebinger; *Vachellia farnesiana* (L.) Wight & Arn.; *Cordia boissieri* A. DC.; and *Opuntia* spp. At higher altitudes, the following are more frequent species: *Havardia pallens* (Benth.) Britton & Rose; *Helietta parvifolia*

(A. Gray) Benth.; *Caesalpinia mexicana* (A. Gray, 1861) E. Gagnon & G. P. Lewis, 2016; *Leucaena pulverulenta* (Schltdl.) Benth.; and a naturalized tree from southern Mexico—*Leucaena leucocephala* (Lam.) de Wit. In the highest zone, *Quercus fusiformis* Small and *Q. canbyi* Trel. occur (Cerro de La Silla 2009, Alanís-Flores et al. 2010).

Climate.—Temperatures of the spots where tree crickets were singing were measured using a Steren thermometer, Model TER-150, with a range of -10 to 50°C.

Preservation of specimens.—Specimens were preserved in 70% ethyl alcohol.

Morphological measurements.—Measurements were made after the specimens were euthanized by freezing or by immersion in 70% ethyl alcohol. Total body length refers to the midline length from the tip of the labrum to the apex of the subgenital plate, not including antennae, tegmina, limbs, or cerci. 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. Female ovipositors were measured from the 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 an AmScope Stereoscope, magnification WF10× to 2× to 4× (photographs made using a Huawei P30PRO cellphone camera with a Leica Vario-Summilux-H1.6-3.4/16-125 ASPH lens). Comparison photographs of *N. bipunctata*, *N. cerrojesusensis*, and *N. ottei* were made with a Canon PowerShot S5 IS.

Male genitalia.—The male genitalia complex was extracted and photographed using a Huawei P30PRO cellphone camera with a Leica Vario-Summilux-H1.6-3.4/16-125 ASPH lens. Copulatory blades (Fulton 1915), which are also known as pseudepiphallus (Chopard 1961) or lophi medians (Desutter 1987), are situated just above the subgenital plate. The blades can sometimes be seen if the male's subgenital plate is lowered, including spontaneously on live males.

Results

Neoxabea mexicana Collins & Velazco-Macias, sp. nov.

<http://zoobank.org/170F61F8-6BA5-4D58-AACE-19B51DE91EE2>

Figs 1–5, 8–14

Type-specimen.—**Holotype** ♂ (Fig. 2), alcohol vial. Bosques del Rey, Guadalupe, Nuevo Leon, Mexico. 25°38.21'N, 100°12.26'W, elevation ca 580 masl, urban area adjacent to Cerro de La Silla, C.G. Velazco-Macias & J.G. Velasco-Castañón leg., 15 X 2020.

Holotype description.—Face, head, and pronotum brown. Pedicel and scape brown, each with one protruding tubercle (Fig. 5); remainder of antennomeres translucent whitish with black staining. Palpi light brownish with black line on each segment (Fig. 4). Eye color brown. Wing color brown and whitish or cream. Ventral abdomen brownish with scattered staining (Fig. 9). Dorsal abdomen median terga projections rounded (Fig. 10). Tarsi, tibiae, and femora with translucent pale yellowish tan with no lines or spotting. Tympanal membrane on fore tibiae with whitish rim. Cerci loosely S-curved and brown (Figs 9, 11). Total length 17.0 mm; tegminal length 12.0; tegminal width 4.0; pronotal length 3.0; distal pronotal width 2.0; hind femur length 8.0; cerci 1.5; stridulatory file length 2.0 mm. Right tegminal stridulatory teeth total 55.



Figs 1–5. *Neoxabea mexicana* sp. nov. adults: 1. ♀ habitus; 2. Holotype ♂ habitus; 3. ♀ with larger amount of cream coloring; 4. Black line on palpi; 5. Pedicel and scape tubercles.

Type material.—Located October 2020 on private property in Bosques del Rey, Guadalupe, Nuevo Leon, Mexico. 2 ♂ and 1 ♀ deposited at Universidad Nacional Autónoma de Mexico (UNAM), one ♂ of these designated as the holotype for this species.

The genus *Neoxabea* was determined as the Nuevo Leon specimens lacked spines on the hind tibiae (Figs 1–3). Males display large amounts of dark staining on the tegmina (Fig. 2). Females (Figs 1, 3) display a pair of blackish spots on the lateral edges of brown wings with areas of cream and a pair of less obvious spots embedded in the dark brown areas of the wings at the base. Both sexes have a black line on each segment of the maxillary palpi (Fig. 4) and a protruding tubercle on both the pedicel and scape (Fig. 5). The female in Figure 3 actively mated with one of the two males found on the same property (video in Suppl. material 1).

Male paratype (n=1).—Total body length 17.0 mm, tegminal length 12.5, tegminal width 5.5, pronotal length 3.5, distal pronotal width 3.0, proximal pronotal width 2.2, hind femur length 9.0, cerci 2.25. Stridulatory file length 2.0. Right tegminal stridulatory teeth total 53.

The metanotal gland, color of the ventral abdomen, cerci, distal abdominal terga projections, ovipositor, and copulatory blades are presented in Figs 8–13, respectively. The metanotal gland scutum to scutellum (Walker 1967) ratio is 1:0.6. Long setae cover the ends of two curved structures situated on both sides of the scutellum that project upward into the center orifice of the gland



Fig. 6. Florida State Collection of Arthropods specimens labeled as *N. formosa*. A. ♂ from Atoyac, Veracruz, Mexico; B. Same ♂ lateral view; C. ♀ from Veracruz; D. ♀ from Brownsville, Texas, USA; E. ♀ from Brownsville.

(Fig. 8). The gland area resembles that of *Neoxabea femorata* Walker, 1967 in figure 25 of Walker (1967); however, the scutum of *N. mexicana* sp. nov., is twice as wide as long and has a straight upper edge. Figure 10 provides a closer inspection of the shapes of all eight abdominal terga projections. The most distal (eighth) projection is much smaller in size than the other seven. The cerci are robust and loosely S-shaped (Figs 9, 11, 12). The copulatory blades (main lobes of pseudepiphallus) touch at the midline while in a rested position and hook upward (Fig. 13A–C). Photos of additional structures in Suppl. material 2.

Female (n=2).—One female was not euthanized and only partially measured. Latticed vein pattern on wings with a single large dark pair of spots at lateral edges mid-wing (Figs 1, 3), and a second pair of spots at the base of the wings. The degree of brown and cream varies. Total body length 16.0 mm, pronotal length 2.5–3.0, distal pronotal width 2.0–2.5, proximal pronotal width 1.5–2.0, hind femur length 7.5–8.2, cerci 2.0, ovipositor length 5.0. The tip of the ovipositor (Fig. 12) does not extend beyond the tips of the hindwings.

Morphological differences.—The maxillary palpi of *N. mexicana* sp. nov. have a longitudinal black line (Fig. 4), which is ruddy on *N. bipunctata*. The numerous darkened areas on the male tegmina of *N. mexicana* sp. nov. are not found on *N. bipunctata*. Female *N. mexicana* sp. nov. have a pair of black spots mid wing, and a pair of spots at the base of the wings. *N. bipunctata* also has a total of two pairs of spots, but the proximally placed spots are not at the base of the wings. The tubercle on the pedicel of *N. mexicana* sp. nov. is well-developed, while there is generally a very small dimple on the pedicel of *N. bipunctata*. See other species comparisons in Fig. 17A–R and Table 1.

Song.—Calling song recordings were made in captivity by CGV-M (Suppl. material 3, 4). Waveform review revealed that this species has bursts of trilling with 36 pulses per second at 26.6°C (Fig. 14). Pulse rates of the songs at different temperatures by this species and three other *Neoxabea* species occurring in North and Central America were plotted on a pulse rate vs temperature graph (Fig. 15). Although only a single recording with an accurate temperature for *N. ottei* and two recordings for *N. cerrojesusensis* are available, several additional recordings were analyzed, and the pulse rate never dropped below 80 pulses per second with am-

Table 1. Non-matching characters of 13 described species of *Neoxabea* when compared to *N. mexicana* sp. nov.

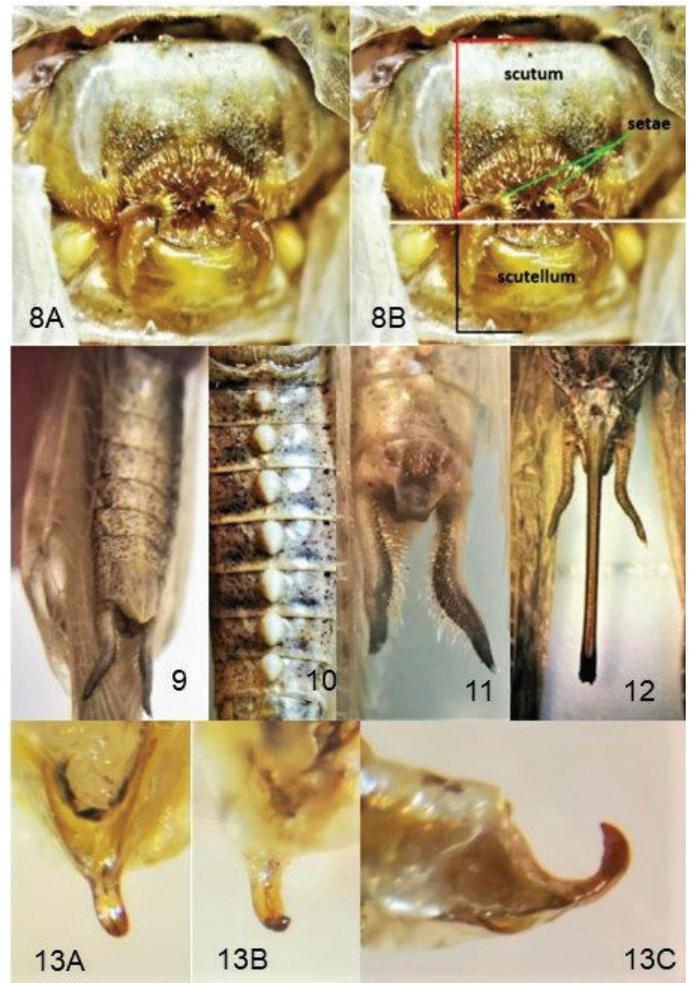
<i>Neoxabea</i> species	Characters not matching <i>N. mexicana</i> sp. nov.	Sources
<i>N. ottei</i> (Collins & van den Berghe, 2014)	< 25 stridulatory teeth; females w/ 4 centrally located wing spots	Collins et al. (2014) (p. 165)
<i>N. astales</i> (Walker, 1967)	< 30 stridulatory teeth; no abdomen terga projections	T. Walker (1967) (fig. 28)
<i>N. bipunctata</i> (DeGeer, 1773)	< 30 stridulatory teeth	T. Walker (1967) (p. 786)
<i>N. cerrojesusensis</i> (Collins & van den Berghe, 2014)	< 30 stridulatory teeth; male tegmina with minimal staining	Collins et al. (2014) (p. 165)
<i>N. obscurifrons</i> (Bruner, 1916)	< 30 stridulatory teeth; drab coloring	T. Walker (1967) (fig. 23)
<i>N. femorata</i> (Walker, 1967)	< 40 stridulatory teeth; striped hind femora	T. Walker (1967) (fig. 28)
<i>N. trinodosa</i> (Hebard, 1928)	75–80 stridulatory teeth	T. Walker (1967) (fig. 28)
<i>N. brevipes</i> (Rehn, 1913)	Spotting on limbs; song > 54 pps at 19°C	T. Walker (1967); Zefa et al. (2018)
<i>N. enodis</i> (Walker, 1967)	Bold cephalic pattern; no abd terga projections	T. Walker (1967) (fig. 16)
<i>N. lepta</i> (Walker, 1967)	Long, thin, straight cerci; no abd terga projections	T. Walker (1967) (fig. 6)
<i>N. meridionalis</i> (Bruner, 1916)	Distinct tegmina staining; no abd terga projections	T. Walker (1967) (fig. 12)
<i>N. formosa</i> (Walker, 1869)	Females with four centrally located spots on wings	F. Walker (1869)
<i>N. quadrula</i> (Walker, 1967)	Cerci with large swelling; 35 stridulatory teeth	T. Walker (1967) (figs 9, 28)



Fig. 7. Academy of Natural Sciences in Philadelphia specimens labeled as *N. formosa*. A. ♀, Brownsville, USA; B. ♀, Coatepec, Veracruz, Mexico.

bient temperatures above 22°C. Permit limitations allowed only two nights of recordings. The pulses per second rate of *N. mexicana* sp. nov. is less than half of that for *N. bipunctata*, *N. ottei*, and *N. cerrojesusensis*. Spectrograms review revealed a calling song carrier frequency of 3.6 kHz at 26.6°C and 3.4 kHz for the pre-singing stuttering (Fig. 16). When compared to the frequencies of the other three *Neoxabea* species mentioned above, *N. mexicana* sp. nov. had a more marked change in the frequency of the stuttering versus the frequency of the singing.

Calling song tone comparison.—The tone of the trilling portion of the song of *N. mexicana* sp. nov. is more musical and flute-like



Figs 8–13. Morphology of *N. mexicana* sp. nov. 8A. Metanotal gland; 8B. Labeled metanotal gland; 9. Ventral abdomen color and subgenital plate on live male; 10. All eight projections on dorsal abdominal terga of male; 11. Dorsal view of male cerci; 12. Ventral view of female ovipositor; 13A. Ventral view of copulatory blades (main lobe of pseudepiphallus) of holotype male; 13B. Dorsal view; 13C. Lateral view.

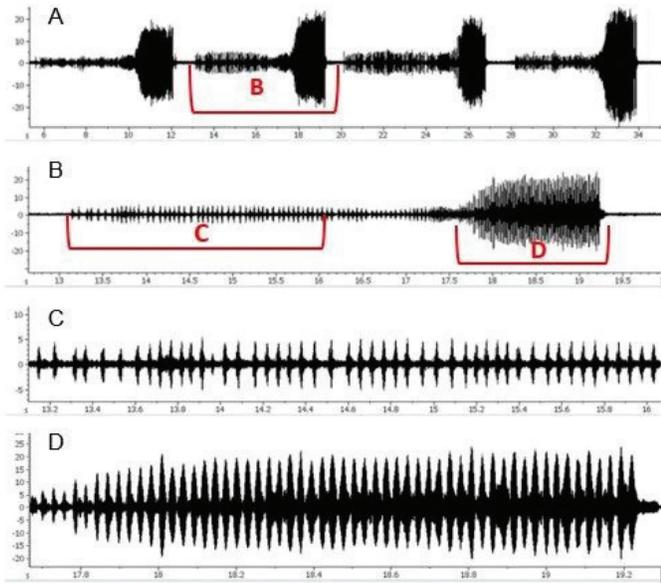


Fig. 14. Waveforms of the calling song of *N. mexicana sp. nov.* at 26.6°C (after applying 2 kHz high pass filtering); A. Six bursts of singing in 50 sec.; B. One burst of singing with warm up stuttering before next burst of singing; C. One second of warm up stuttering showing a total of 17 pulses (click sounds); D. One second of singing (36 pulses per second).

than the buzzy sound of the faster song of *N. bipunctata*. Both species have a pre-trilling stuttering, but the stuttering of *N. mexicana sp. nov.* is longer in duration, more consistently present, and was found to be more flute-like in tone even at moderate temperature (22.7°C). *Neoxabea mexicana sp. nov.* has a 200 Hz difference between the frequency of the stuttering and the song trilling, while the frequency of *N. bipunctata* remains constant.

Key to *Neoxabea* species in North and Central America

- 1 Females..... 2
- 1' Males (male of *N. formosa* unknown) 6
- 2(1) Two pairs of prominent dark spots on lateral edges of female wings at rest; located in mid portion (Fig. 17C–E)..... 3
- 2' Two pairs of prominent dark spots on lateral edges of female wings at rest; with one of the pairs located at base (Fig. 17A, B)..... 5
- 3(2) Ruddy line on each segment of the maxillary palpi; slight dimple on pedicel (Fig. 17C, J, R) ♀ *N. bipunctata*
- 3' Dark brown or black line on each segment of the maxillary palpi 4
- 4(3') Dimple on pedicel unknown (only scape present on holotype) ♀ *N. formosa*
- 4' Moderate dimple on pedicel (Fig. 17D, N, Q) ♀ *N. ottei*
- 5(2') Moderate dimple on pedicel (Fig. 17B, M, P) ♀ *N. cerrojesusensis*
- 5' Prominent tubercle on pedicel (Fig. 17A, K, O)..... ♀ *N. mexicana*
- 6(1') Large amount of dark brown staining on male tegmina; black line on each segment of the maxillary palpi; prominent tubercle on pedicel; song with < 40 pulses per second at 26.0°C; stridulatory teeth count > 50 (Fig. 17E, K, O) ♂ *N. mexicana*
- 6' No or minimal male tegmina staining; dimple on pedicel; stridulatory teeth count < 30 7
- 7(6') Ruddy line on each segment of the maxillary palpi; pedicel with slight dimple; song with > 100 pulses per second at 26.0°C (Fig. 17H, J, R) ♂ *N. bipunctata*

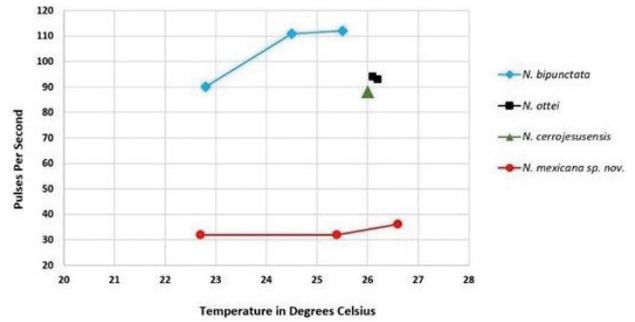


Fig. 15. Comparing calling song pulse rates of *N. mexicana sp. nov.* to *N. bipunctata*, *N. ottei*, and *N. cerrojesusensis*. Data for recordings in Suppl. material 5.

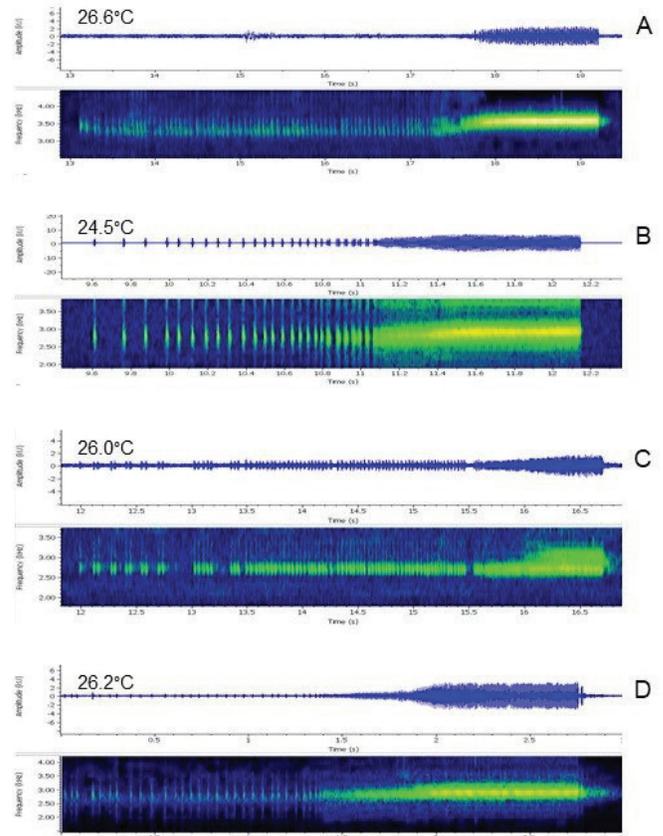


Fig. 16. Waveforms and spectrograms highlighting stuttering and singing. A. *N. mexicana sp. nov.*; B. *N. bipunctata* (Source: SINA); C. *N. cerrojesusensis*; D. *N. ottei*.

- 7' Dark brown or black lines on each segment of the maxillary palpi; moderate dimple on pedicel; song with >70 pulses per second at 26.0°C..... 8
- 8(7') Tegmina dark staining pattern generally a full X; resting tegminal width > 4.5 mm (Fig. 17I, N, Q) ♂ *N. ottei*
- 8' Tegmina dark staining pattern generally the top half of an X; resting tegminal width < 4.5 mm (Fig. 17G, M, P) ♂ *N. cerrojesusensis*

Neoxabea species comparisons.—The 13 described species of *Neoxabea* can be ruled out as *N. mexicana sp. nov.* with non-matching characters, as in Table 1.

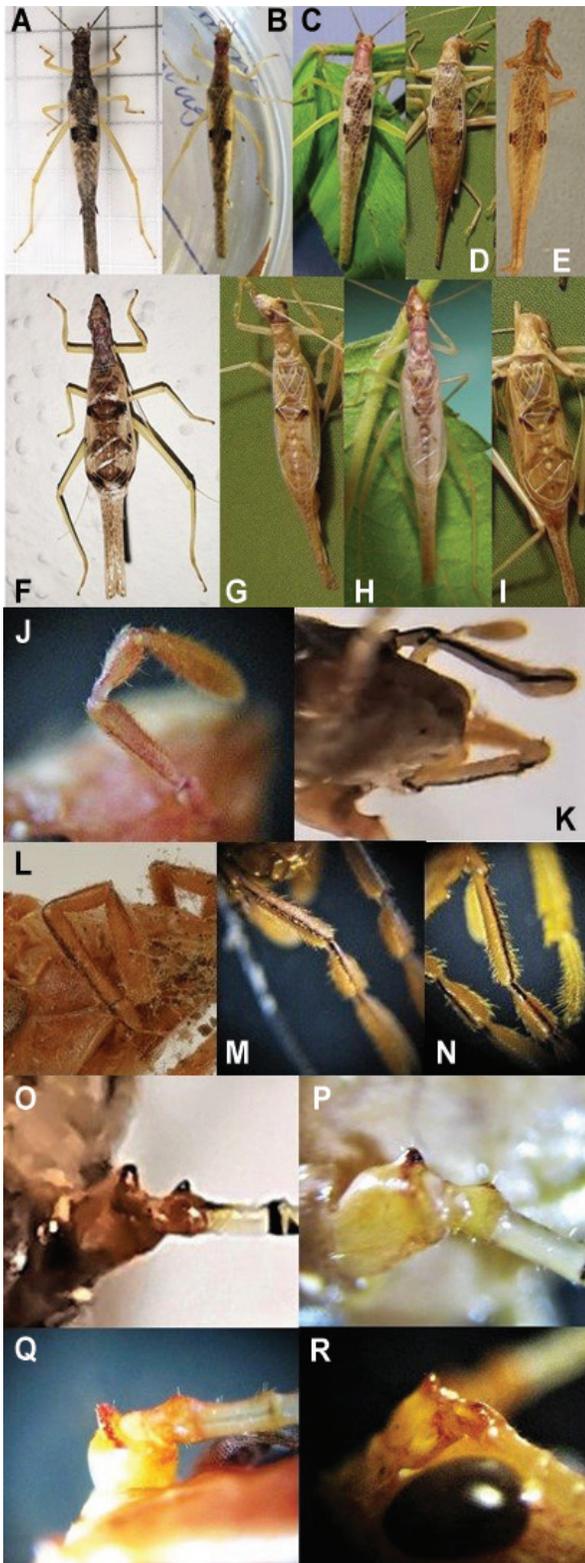


Fig. 17. Images of adult wing patterns, palpi markings, and pedicel tubercles for species in the *Neoxabea* key. A. *mexicana* sp. nov. ♀; B. *cerrojesusensis* ♀; C. *bipunctata* ♀; D. *ottei* ♀; E. *formosa* ♀; F. *mexicana* sp. nov. ♂; G. *cerrojesusensis* ♂; H. *bipunctata* ♂; I. *ottei* ♂; J. *bipunctata*; K. *mexicana* sp. nov.; L. *formosa*; M. *cerrojesusensis*; N. *ottei*; O. *mexicana* sp. nov.; P. *cerrojesusensis*; Q. *ottei*; R. *bipunctata*.

Discussion

This investigation revealed the following characters for *Neoxabea mexicana* sp. nov.: well-developed tubercles on the pedicel as well as the scape; a black line on all segments of the maxillary palpi; a large amount of dark staining on the male tegmina, and one pair of dark spots on the wings of females located at the base. These characters, along with the calling song rate and stridulatory teeth count, are distinctly different from those in *N. bipunctata*, which is also reported from Mexico. While the warm-up stuttering and the singing phase of *N. bipunctata* remain at a consistent frequency, the song of *N. mexicana* sp. nov. consistently shows a rise from the stuttering phase to the singing phase of up to 200 kHz.

In this paper, we focus on comparisons to *N. bipunctata*, since that species is well studied and documented as occurring in Mexico. Comparisons to other species of *Neoxabea* in Table 1 and the key to *Neoxabea* of North America and Central America confirm the diagnosis of a new species. The dark lines on the maxillary palpi of the holotype of *N. formosa* are distinctly different from the fainter ruddy lines on *N. bipunctata*. The ventral abdomen is too degraded from age to check for the two dark lines described by F. Walker. Suppl. material 6 provides photos of *N. formosa*. Since a species described from Nicaragua, *N. ottei*, also has females with four spots on the wings in the same positions as those on the *N. formosa* holotype, these two species cannot currently be separated without examining males of *N. formosa*. The only known locality of *N. formosa* is a dormant volcano, Orizaba, which is the third highest in North America. This habitat could easily be a location with uncommonly encountered species.

Our recommendation for male specimens currently labeled as *N. formosa* in collections is to treat them as either *N. formosa* or *N. mexicana* sp. nov. until a living male can be verified as *N. formosa*. Female specimens labeled as *N. formosa* with two pairs of centrally located spots on the wings cannot currently be distinguished from *N. ottei*, but the intensity of the line on the maxillary palpi can be used for differentiating between *N. bipunctata* and *N. formosa*.

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Supplementary material 1

Author: Carlos Gerardo Velazco-Macias

Data type: Movie (mov. file)

Explanation note: Mating pair of *N. mexicana* sp. nov..

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Link: <https://doi.org/10.3897/jor.26.62000.suppl1>

Supplementary material 2

Author: Carlos Gerardo Velazco-Macias

Data type: Image (jpg. file)

Explanation note: Structures of *N. mexicana* sp. nov.: A. Holotype right wing stridulatory file with teeth; B. Female tympanal membrane; C. Male tympanal membrane with front limb claw; D. Spermatophore; E. Ovipositor.

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Link: <https://doi.org/10.3897/jor.26.62000.suppl2>

Supplementary material 3

Author: Carlos Gerardo Velazco-Macias

Data type: SWF file

Explanation note: Recording of captive male.

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Link: <https://doi.org/10.3897/jor.26.62000.suppl3>

Supplementary material 4

Author: Carlos Gerardo Velazco-Macias

Data type: SWF file

Explanation note: Recording of captive male.

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Link: <https://doi.org/10.3897/jor.26.62000.suppl4>

Supplementary material 5

Author: Nancy Collins

Data type: Excel spreadsheet

Explanation note: Graph of recording data for four species of *Neoxabea*.

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Link: <https://doi.org/10.3897/jor.26.62000.suppl5>

Supplementary material 6

Author: Ben Price

Data type: Image (jpg. file)

Explanation note: Photographs of the female holotype for *N. formosa* – taken at the Natural History Museum in the UK.

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Link: <https://doi.org/10.3897/jor.26.62000.suppl6>