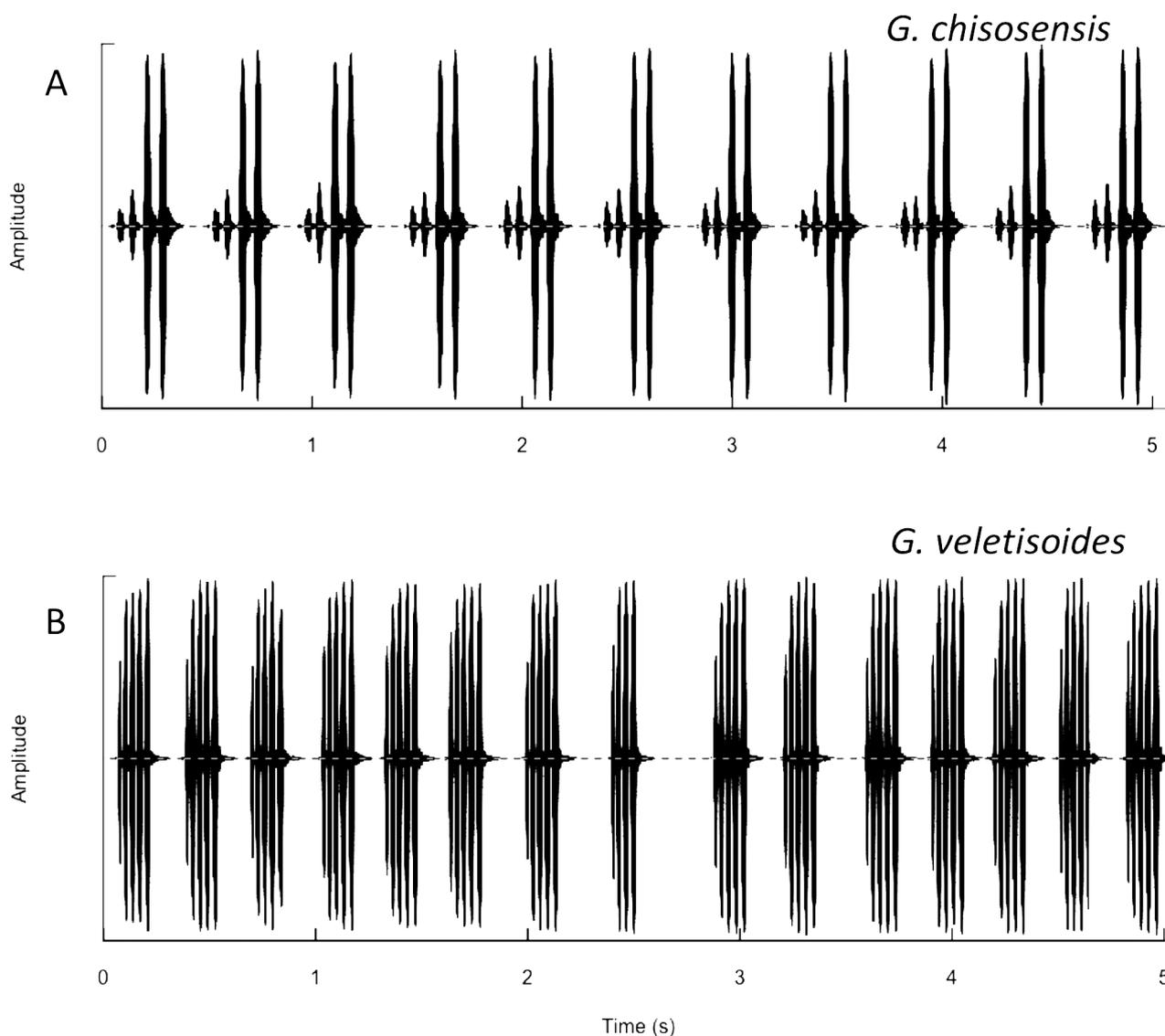


## The Chisosensis Group

*G. chisosensis* Weissman & Gray, n. sp. and *G. veletisoides* Weissman & Gray, n. sp.

Geographically distant but genetically closely related 4-5 pulse chirping species (Figs 189, 190), separated by pulse rate, geography, and DNA (Fig. 191); closely related to *G. montis* genetic Clades 2 and 3 which are geographically intermediate.



**FIGURE 189.** Five second waveforms of calling songs of (A) *G. chisosensis* and (B) *G. veletisoides*. (A) *G. chisosensis*: holotype male, at 24°C; (B) *G. veletisoides*: (R06-21) type locality (S06-30), at 25°C.

### *Gryllus chisosensis* Weissman and Gray, n. sp.

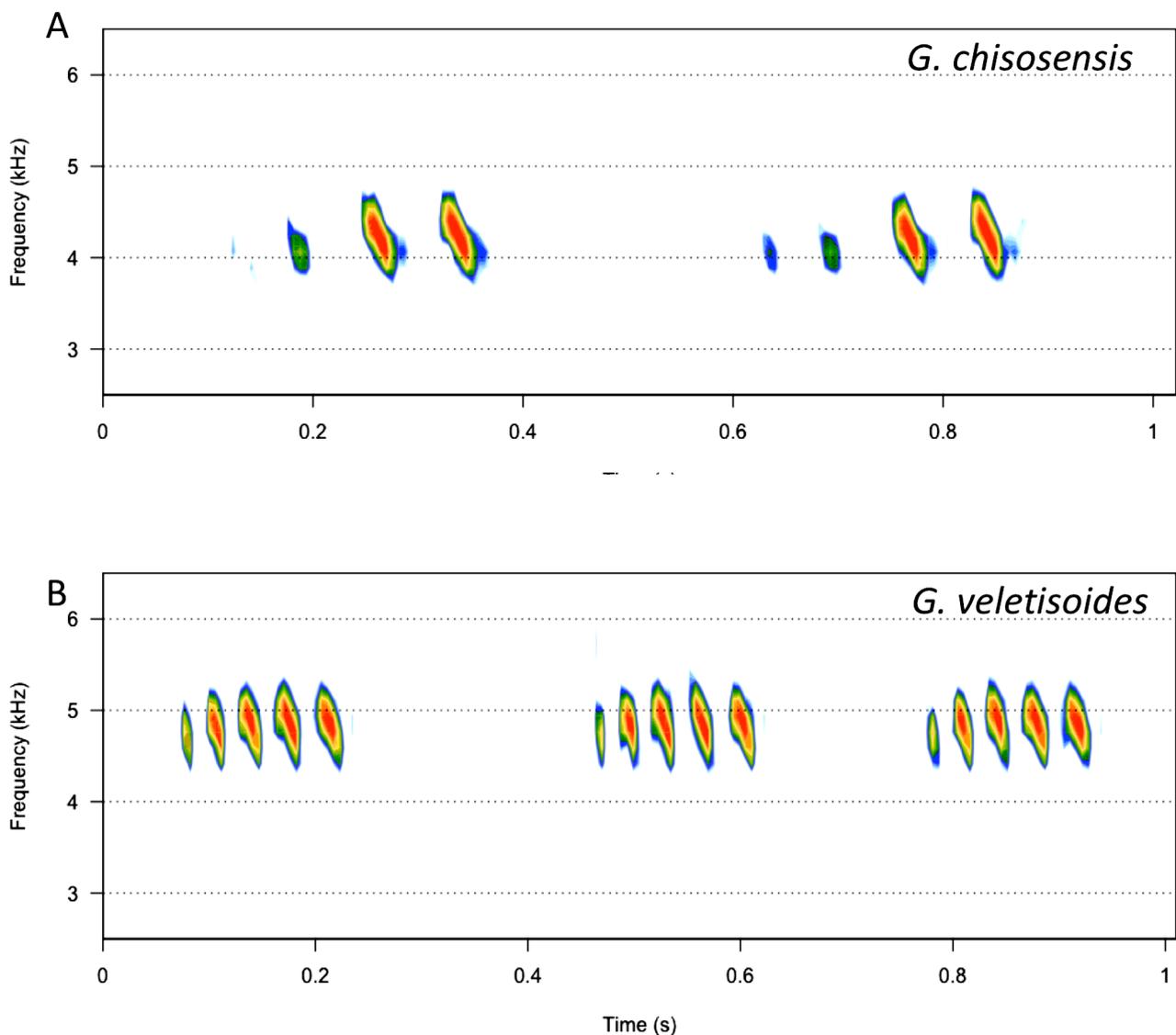
Chisos Mountains Field Cricket

Figs 189–194, Table 1

*Distribution.* Known only from the Chisos Mountains in Big Bend National Park, Texas.

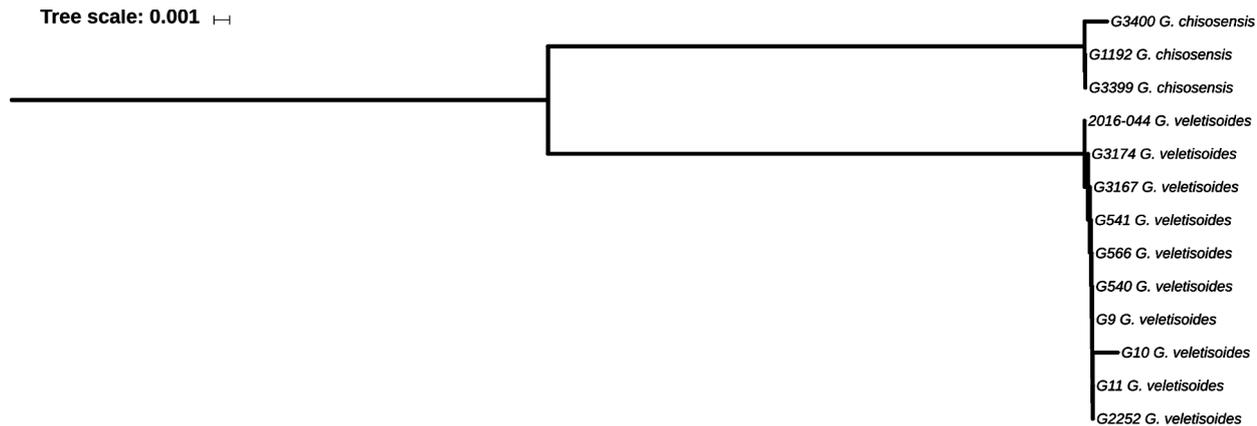
*Recognition characters and song.* A sky island, rock associated, completely black except for inside of hind femur (Fig. 192), long cerci probably always longer than ovipositor in situ, always short hind winged cricket. *Song* (Fig. 193, R07-116) a chirp of 4-5 p/c, 90-150 c/m, PR 14-17 at 25°C. Separated from morphologically similar *G.*

*longicercus*, whose nearest populations are in the Chianti Mountains, just south Shafter, Presidio Co., (or ~116 air km NW of the type locality) by the following: while both taxa have long cerci, > 168 teeth, and associated with rocky habitats, *G. longicercus* generally has more teeth/mm and is not usually found in pinyon-juniper oak woodlands but in open, rocky Sonoran and Chihuahuan desert scrub habitats. The pulse rate in all western *G. longicercus* is typically <14 at 25°C while it is >14 in *G. chisosensis*. This higher pulse rate is approached by some Mt. Lemmon (R90-180, R90-235, R94-76, R09-132, R12-48), and Tucson (R90-240), Arizona, *G. longicercus* but not quite equaled. Even a male *G. longicercus* from Mountainair, New Mexico (S15-52, R15-341), with only 155 file teeth, fewer teeth than any of the 5 males of *G. chisosensis*, sang with a PR of 10.8. But, perhaps most importantly for these isolated crickets, is that their 16S, ITS2, and multilocus DNA profiles are significantly different from that seen in all populations of *G. longicercus*. Also, morphologically similar to sympatric, and more widespread and common, *G. transpecos* but separated (Table 1, p. 18) by no overlap in number of teeth and PR and minor overlap in teeth/mm and cerci length. The latter two taxa are also separated by microhabitat in that *G. chisosensis* prefers deep piles of rocks while *G. transpecos*, while preferring rocky habitats like rocky road cuts, is not associated with deep rock piles. The difference in pulse rate is apparent, in the field, between these three taxa, with *G. chisosensis* somewhat in between the PR of *G. longicercus* and *G. transpecos*.



**FIGURE 190.** One second spectrograms of calling songs of (A) *G. chisosensis* and (B) *G. veletisoides*, same males as in Fig. 189.

Tree scale: 0.001



**FIGURE 191.** ITS2 gene tree. Collection stop numbers for *G. chisosensis*: S07-36 (G1192); S16-13 (G3399, G3400). Collection stop numbers for *G. veletisoides*: S03-21 (G9, G10); S03-23 (G11); S06-30 (G540, G541, G566); S12-41 (G2252); S15-81 (G3167, G3174, 2016-044).



**FIGURE 192.** Holotype male (left) of *G. chisosensis*. Female (right) from near type locality in Big Bend National Park (S16-13).

*Holotype.* Male (Fig. 192). USA. Texas. *Brewster Co.*, Big Bend National Park, Basin Junction Road, near Lost Mine Trail, 12-vi-2007, 5460', 29° 16.471' -103° 17.211', S07-36, R07-116, G1192, right tegmen removed, 192 teeth, BL 18.32, HF 11.81, left cercus 17.71. Deposited at CAS, Entomology type # 19225. GenBank accession numbers: 16S = MK446451; ITS2 = MK441857.

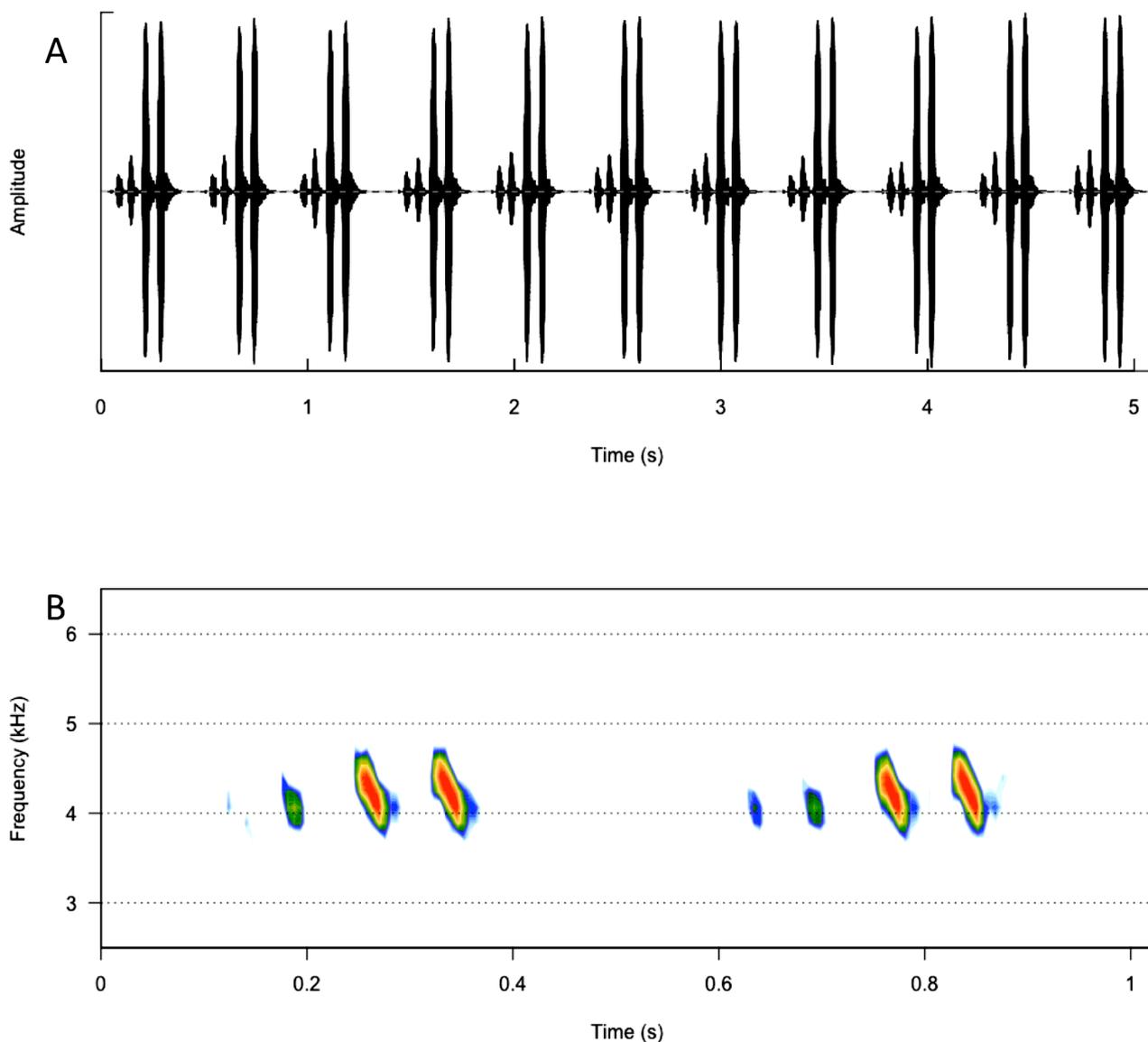
*Paratypes.* (4♂ 1♀) **Texas.** *Brewster Co.*, Big Bend National Park, tunnel 18.7 m SE Panther Junction, 9-vi-1985, 2057' 29° 12' 08.04" -102° 58' 38.87" (S85-57) 1♂; 5-vi-1991 (S91-42) 2♂. Basin Junction Road, 28-v-2016,

5555', 29° 16' 37.68" -103° 16' 59.95" (S16-13) 1♂, 1 last instar female (molt to adult 6-vi-2016).

*Song records only.* Type locality, 5-vi-1991 (S91-41) 1♂.

*Derivation of name.* Named after the Chisos Mountains, a sky-island mountain range that is the only known locality.

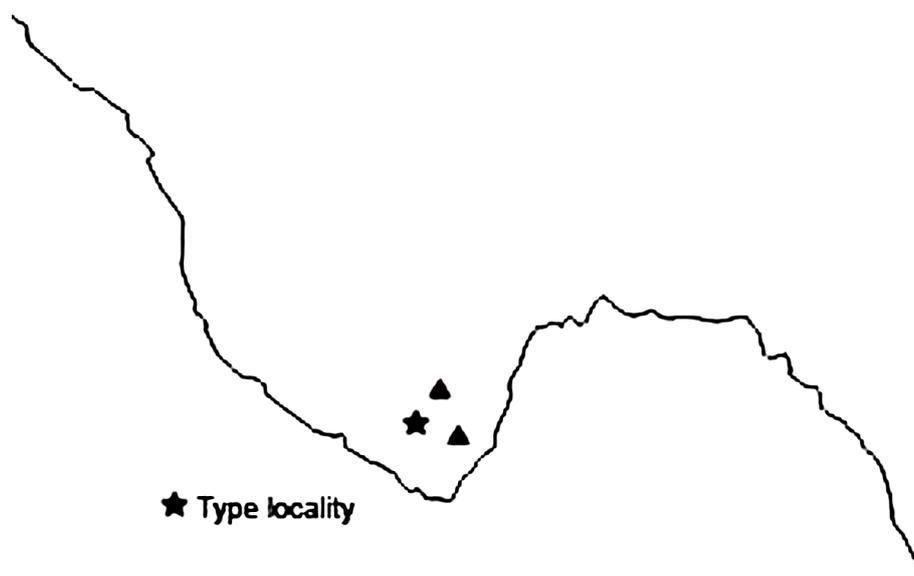
*Geographic range.* (Fig. 194). Restricted to the Chisos Mountains in the Big Bend region of Texas.



**FIGURE 193.** Calling song (R07-116) of holotype *G. chisosensis*, recorded at 24°C. Top: 5 s waveform; Bottom: 1 s spectrogram. Note that in this recording, the first two pulses are much quieter than the last two pulses. The four additional recordings that we have of *G. chisosensis* males also show a similar pattern (R85-134 [S85-57]; R91-71 & R91-129 [S91-42], R16-27 [S16-13]). It is fairly common in *Gryllus* for the first few pulses to be of lower amplitude than the last pulses, so we caution that, even if typical for this species, this is not a diagnostic feature.

*Habitat.* Pinyon-Juniper oak woodland, usually in extensive rock piles on talus slopes. The immediate area around the tunnel on the road to Rio Grande Village is not tree associated, or with talus slopes, but the pulse rate in the 3 males collected there agrees with that from around the type locality. Unfortunately, given the age of the material, no DNA was available for comparison.

*Life cycle and seasonal occurrence.* Egg diapause not checked but we assume not present. Probably one generation/year. Singing adults only known from May 28<sup>th</sup> until June 12<sup>th</sup> as collecting limited. Our only collected female was a last instar on 28-v-2016. No males heard at the tunnel 30 km SE Panther Junction on 28-v-2016 nor attracted to oatmeal.



**FIGURE 194.** Known distribution of *G. chisosensis*.

*Variation.* Nothing of note in the small series collected by us.

*DNA.* Multilocus G3400 maps by itself (Gray *et al.* 2019) but associated with the Lineaticeps Group and *G. veletisoides*. ITS2 (Fig. 191) also places *G. chisosensis* near *G. veletisoides*. Despite phenotypic, ecological, and song similarity, *G. chisosensis* and *G. longicercus* are not especially closely related: genetic similarity using Tamura-Nei distances for ITS2 was  $98.8 \pm 1.02$  within *G. chisosensis* ( $n = 3$ ), and  $98.9 \pm 0.69$  within *G. longicercus* ( $n = 16$ ), but only  $85.3 \pm 0.28$  between species [Note: ITS2 distances are heavily influenced by repeat regions and gaps; 85% similarity in ITS2 is not equivalent to 15% sequence divergence in coding DNA].

*Discussion.* In the field, the pulse rate of *G. chisosensis* never sounded slow enough for *G. longicercus*, despite the appropriate rocky habitat, long cerci, and high number of file teeth. Only after uncovering initial significant differences in 16S (ca. 3.4% sequence divergence) and ITS2, with later agreement from multilocus analysis (Gray *et al.* 2019), coupled with its sky island habitat, did we decide to call this a species endemic to the Chisos Mountains. The slower pulse rate could also be distinguished from sympatric *G. transpecos* when both found together at the type locality and at the northwest end of the tunnel 30 km SE Panther Junction (S85-57 and S91-42). This cricket is never common and where found, is difficult to collect since it retreats into the deep rock piles from whence it may continue to sing while rocks are being moved, a behavior seen in other rock-chirping species.

The Chisos Mountains are home to at least two other described endemic orthopteroids: the walking stick *Diapheromera torquata* Hebard and the katydid *Paracyrtophyllus excelsus* (Rehn and Hebard).

***Gryllus veletisoides* Weissman & Gray, n. sp.**

West Coast Spring Field Cricket

Figs 137, 138, 189–191, 195–200, Table 1

‘G. VII’ of Weissman & Rentz 1977a.

*G. veletis* of Weissman *et al.* 1980.

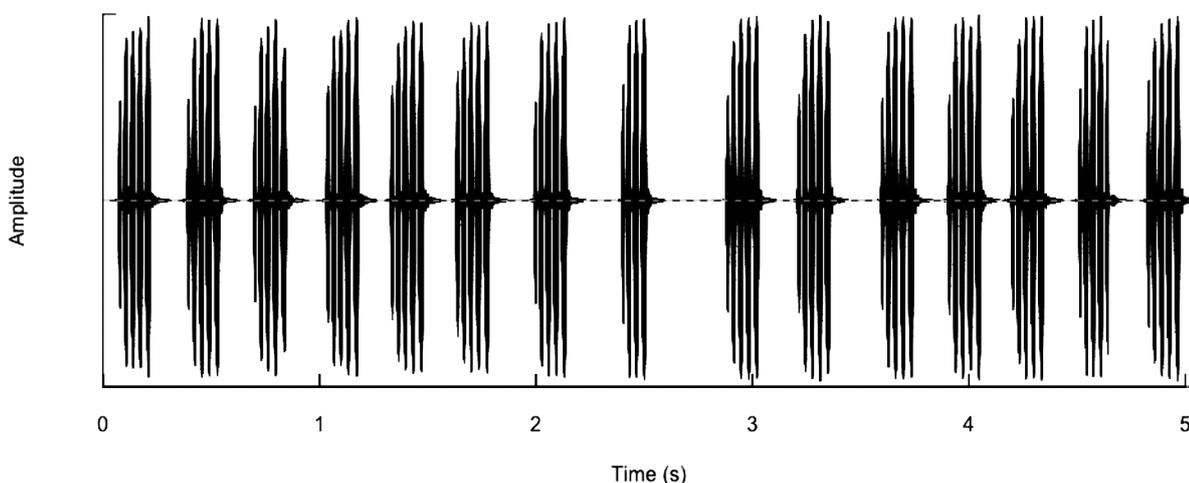
*G. veletis* and ‘G. western veletis’ of DBW notebooks.

*Distribution.* California and Oregon west of the Sierra Nevada and Cascade Mountain Ranges.

*Recognition characters and song.* Medium sized, cerci short (usually <10 mm) and never as long as ovipositor in situ, black except for occasional red area on inside hind femur (Fig. 195), almost always short hind winged, wide pronotum, spring and summer species usually associated with grassy, frequently moist areas. Song a slow, usually irregular chirp (Fig. 196, R06-21)) with 4-5 (range 3-6) p/c and a PR generally from 21 to 30 at 25°C. There are only three *Gryllus* species with overlapping distributions and similar slow chirp songs: *G. brevicaudus* has a shorter ovipositor, slightly longer cerci, and a unique (especially in males) yellow-orange tinged area on the lateral tegmina field; *G. pennsylvanicus* overlaps in distribution only in west-central Oregon and differs (Table 1, p. 18) from *G. veletisoides* by having more file teeth, a slower PR, and an egg diapause that results in summer, and not spring adults; and *G. saxatilis* which differs in habitat (usually much drier and with rocks), longer cerci, and more teeth in file.



**FIGURE 195.** Right: Holotype male of *G. veletisoides*. Left: Female of *G. veletisoides*, also from type locality (S06-30).



**FIGURE 196.** Calling song (R06-21) of *G. veletisoides* from type locality (S06-30), recorded at 25°C.

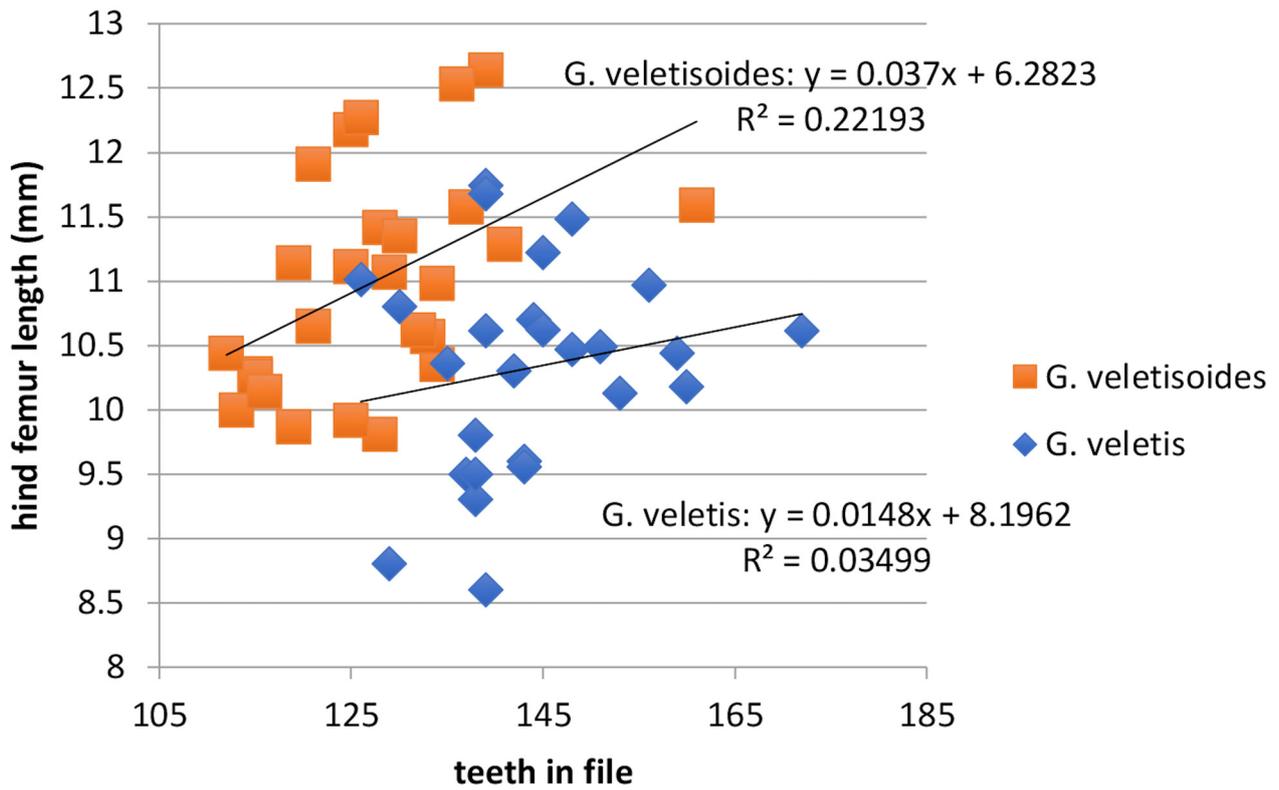


FIGURE 197. Regression file teeth number vs. hind femur length in *G. veletisoides* vs. *G. veletis*.

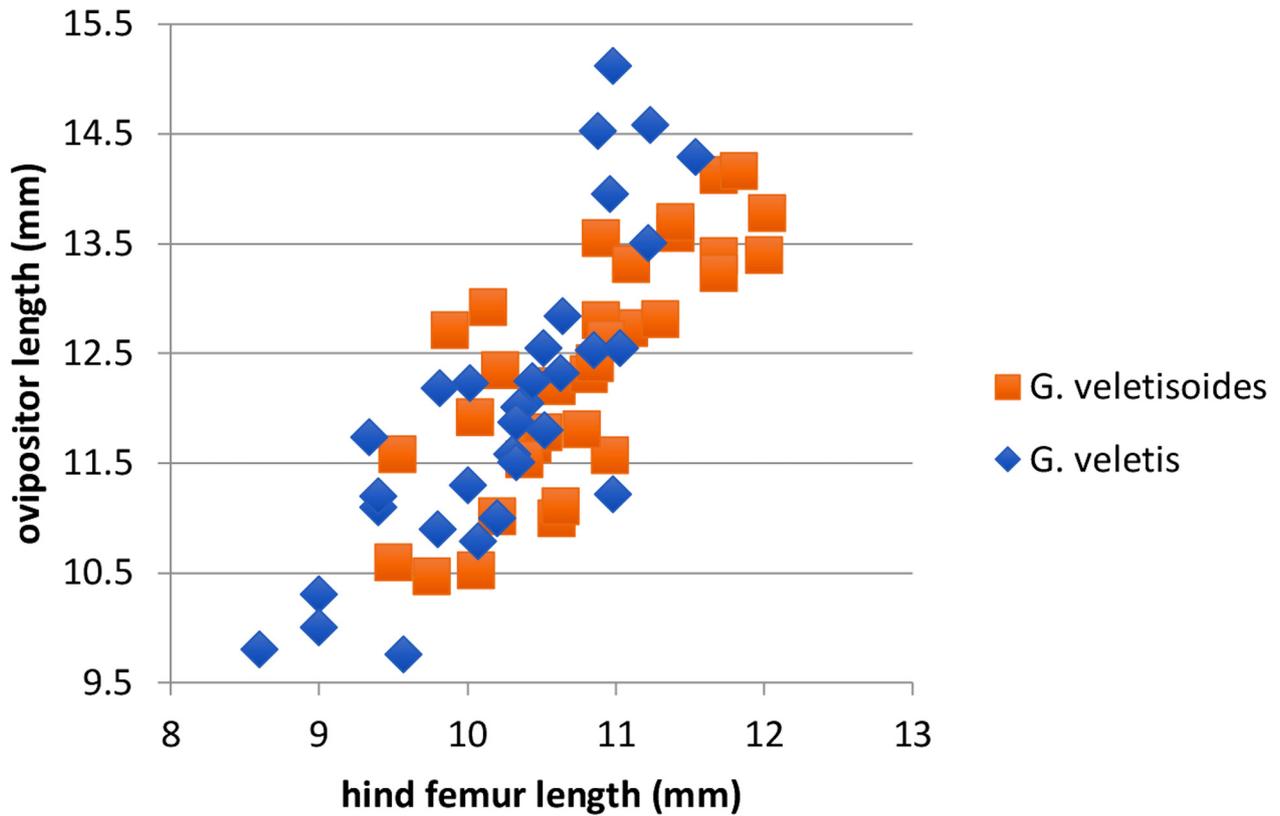


FIGURE 198. Regression hind femur length vs. ovipositor length in *G. veletisoides* vs. *G. veletis*.

Differs from morphologically similar, always allopatric *G. veletis* by geography (latter always east of the Sierra Nevada and Cascade Mountain Ranges), relatively fewer teeth in the file (Fig. 197), and different DNA (Fig. 6, p. 28). They are not separated by ovipositor length (Fig. 198). The two taxa are some 120 km apart between the nearest California localities of Acton (S09-26) and Barstow (S03-73).

**Holotype.** Male (Fig. 195). USA, California, Santa Clara Co., Los Gatos, Los Gatos Creek at Lark Ave., 10-v-2006, 82m, 37° 15' 09.41" -121° 57' 47.52. D.B. Weissman. S06-30, R06-22, G566. BL 20.84, HF 11.08, RC 8.48. GenBank accession numbers: 16S = MN136662; ITS2 = MN136861. Right tegmen removed 132 teeth, file length 2.9, TL 9.4, TW 3.9. Type deposited in CAS, Entomology Type #19276.

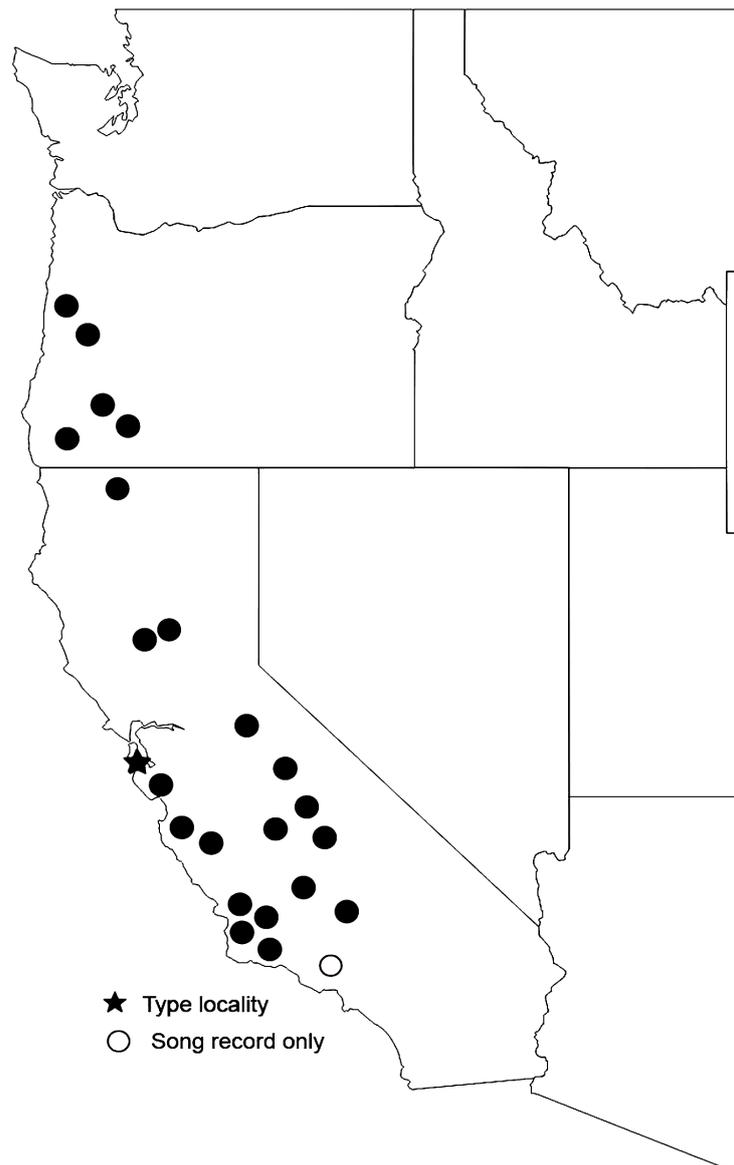
**Paratypes.** (Total 134♂ 82♀). **California.** *Calaveras Co.*, Lake Comanche Recreational Area near Valley Springs, 15-vi-2013, 74m, 38° 13' 28.18" -120° 55' 27.46" (S13-37) 5♂ 5♀. *Colusa Co.*, Colusa Sacramento River SRA, 18-viii-2015, 96' (S15-81) 39° 13' 12.3" -122° 00' 56.1, 4♂ 8♀. Willows, 29-viii-2003, 120' (S03-87) 2♂ 1♀. *El Dorado Co.*, Fannon Reservoir, 29-iii-2005, 2340' (S05-39) 1♂ 1♀. *Fresno Co.*, Fresno, 6-vi-1980, 2♂. Jacalitos Canyon, 18-viii-2001, 840-1020' (S01-97) 2♂; 4-v-2003 (S03-31 & 32) 3♂. Kingsburg, 18-iv-2003, 340' (S03-21) 3♂; 4-v-2003, (S03-25) 14♂ 5♀. *Kern Co.*, Bakersfield, Kern River bed dry wash at Cal State Bakersfield, 5-viii-1980, 372' (S80-70) 3♂ 2♀; 18-vi-2012 (S12-43) 1♂. Sand Ridge 4 m N Edison, 22-xii-1983, 1000', (S83-163) 1♂. *Los Angeles Co.*, Acton, 29-vi-2003, 2800' (S03-75) 1♂ 1♀; 17-vi-2012 (S12-41) 1♂ 1♀. Santa Clara River bed near Acton, 28-v-2009 (S09-26) 1♂ 1♀. *Marin Co.*, San Rafael, 21-vii-2007 (S07-75) 1♂. *Mariposa Co.*, El Portal, El Portal Middle School, 25-iv-2010, 1700' (S10-12) 5♂. *Merced Co.*, 4 m E Dos Palos, 29-viii-1981 (S81-75) 2♂ 4♀. *Monterey Co.*, King City, 7-viii-1980 (S80-77) 2♂. *San Benito Co.*, Pinnacles National Monument, Chalone Campground, 22-iv-2006, 1070' (S06-14) 2♂. Hwy. 25 1.2 m S Paicines, 1-viii-1980, 1000' (S80-53) 3♂. Hwy. 25 4.5 m N Paicines, 1-viii-1980 (S80-54) 1♂. Road to Fremont Peak State Park 4.7 m S Hwy. 156, 21-iii-2003, 600' (S03-6) 3♂ 3♀. *San Luis Obispo Co.*, 3 m S Nipomo, 15-iii-1985, 200' (S85-35) 1♂ 2♀. Santa Margarita, 23-vi-1992, 800' (S92-55) 3♂. *Santa Barbara Co.*, Guadalupe, 15-iii-1985 (S85-33) 2♀. Hwy. 166 0.7 m W Santa Maria, 23-vi-1992, 0' (S92-56) 7♂ 4♀. *Santa Clara Co.*, Campbell, 3-viii-2005, 250' (S05-71) 2♂. Los Gatos, 3-iv-1990 (S90-27) 2♀; 20-ii-1995 (S95-17) 1♂; early July (S03-77) 1♂. Type locality, 6-iii-1995 (S95-2A) 1♂; 2-x-1995 (S95-103) 1♂; 14-viii-1997 (S97-119) 7♂ 7♀; 12-ix-2000 (S00-45) 1♂; 22-iv-2002 (S02-4) 1♂ 1♀; 5-vii-2003 (S03-82) 1♂; 10-v-2006 (S06-30) 12♂ 11♀. Palo Alto, 14-iv-1984 (S84-16) 2♂ 1♀. Mt. View, 9-vi-1982 (S82-20) 1♂. San Jose, 15-viii-1980 (S80-78) 2♂; 16-v-1987 (S87-28) 3♂ 3♀. Stanford University, Lake Lagunita, 26-viii-1983 (S83-113) 1♂; 2-v-1992 (S92-45), song record only. *Santa Cruz Co.*, Ben Lomond, near E Zayante Fire Station, 31-iii-1995, 300' (S95-26) 3♂ 1♀; 20-iv-1996 (S96-24) 3♂ 2♀; 23-iv-2003, (S03-23) 4♂ 1♀. Santa Cruz, 1113 Laurent St., 13-ix-2015 (S15-120) 1♂. *Siskiyou Co.*, Yreka (S83-35) 2♂. *Solano Co.*, Lake Solano County Park, 5-viii-2014, 168' (S14-60) 1♂. *Stanislaus Co.*, Road J9 2m N junction with J17, 5-viii-1980 (S80-69) 1♂. 14.5 m E Gilroy, 29-viii-1981 (S81-78) 2♂. *Sutter Co.*, Sutter Buttes, 14-iii-2015 (S15-2) 1♀. *Tulare Co.*, 1.2-3 m E Springvale, 4-v-2003, 1200' (S03-26 & 30) 4♂. *Ventura Co.*, Los Padres National Forest, Reyes Creek, 3735', 8-v-2005, 34.67920 -119.30810 (DAG 2005-058) 1♂. **Oregon.** *Benton Co.*, Corvallis, 25-v-1983 (S83-38) 3♂ 1♀. *Jackson Co.*, Phoenix, 24-ix-2004, 1500' (S04-132) 1♂. Rogue River, 30-v-1983, 1100' (S83-34) 5♂ 5♀. *Josephine Co.*, Selma, 30-v-1983 (S83-37) 1♂. *Lane Co.*, Eugene, 200', 18-viii-2005 (S05-78) 1♂; 16-vi-2006, (S06-33) 4♂ 4♀.

**Song records only.** **California.** *Los Angeles Co.*, California State University Northridge, Botanic Garden area, 8-v-2003, 812' (S03-47), at least 3 males heard; most southern known locality.

**Derivation of name.** Named in reference to its being morphologically and song-wise almost indistinguishable from *G. veletis*.

**Geographic range.** (Fig. 199). Includes California's Central Valley and the western foothills of the Sierras (El Portal, S10-12), and up to 1138m in Ventura Co.

**Habitat and behavior.** Usually areas with increased moisture like open meadows, along streams, and watered gardens but also in vegetation in dry river beds (Acton, S12-41) and canyons (Jacalitos Canyon, S03-31 & 32) all usually at elevations below 850m. At Ben Lomond, Santa Cruz Co., CA, on sandy substrate. Many males sing from under cover of vegetation. Several adult females can be found together under rocks and boards; such associations also seen, but rarely, in adult males (e.g. El Portal, S10-12). Such social behavior is in contrast to the more solitary nature described for eastern *G. veletis* (Alexander & Bigelow 1960), but consistent with *G. veletis* in the west (see discussion under *G. veletis*, p. 145).



**FIGURE 199.** Known distribution of *G. veletisoides*.

*Life cycle and seasonal characteristics.* No egg diapause. Most areas with one generation/year but in selective California populations (e.g. Merced Co., S81-75, and probably other Central Valley localities; Santa Cruz, S15-120; Los Gatos, S97-119 & S00-45; and Campbell, S05-71), in certain, but not every year, one finds DNA confirmed (see G3334 under “DNA” below) second generation adults, although never as common or as widely distributed as first-generation adults. There is an almost 6-week period (mid-June to end of July) during which no males of *G. veletisoides* are heard singing in Santa Clara Co., CA. Eggs from these second-generation females also without an egg diapause (Los Gatos, CA, S97-119) but the hatching nymphs appear to be inconsequential for future generations because they do not become late instars (at which time they can overwinter) before the onset of winter and apparently die off as early instars. Two alternative interpretations for these “second generation” adults are possible: (1) Most eggs laid by first generation females hatch without a diapause but a low percentage have a delay of a few months and nymphs from those latter eggs do not mature until late summer (see Walker 1980 for a discussion of different egg hatching rates in *G. firmus*). (2) These “second generation” adults could be the adults of those “second generation” adults from the previous year, and they overwinter as very early instars or as eggs in diapause. We have not done the careful analysis needed to examine (1). We doubt (2) because even eggs or early instars that overwinter should molt to adult before August. By way of comparison, *G. pennsylvanicus* has diapausing eggs that overwinter

yet next year's adults start singing in early August (Alexander & Meral 1967). Adults of *G. veletisoides* are known from Los Gatos, CA, from 20-ii (S95-17) to 2-x (S95-103) and also from 22-xii-1983 (Sand Ridge, CA, S83-163). The latter 1983 male might be either a second generation 1983 adult or a first generation 1984 adult. We suspect that more late summer collecting within the study area would uncover more of these second-generation populations. On the other hand, the only male heard and collected from Phoenix, OR (S04-132) on 24-ix-2004, is undoubtedly a late surviving first generation male since the weather is probably too cool in coastal southern Oregon to enable maturation of a second generation.

**Variation. Hind femur color:** Usually solid black (Fig. 200) although some with majority of inner aspect reddish. **Hind wing length:** Only one male (Kingsburg, Fresno Co., S03-25) with long hind wings from more than 200 adults. **Tegmina color:** Most black with few brown. All 5 females from Calaveras Co. (S13-37) with tegminal bars. **Cerci length:** Only 1 male (Fresno Co., S03-25) and 1 female (Calaveras Co., S13-37) with cerci longer than 10mm. Cerci are so short that usually intact even late in the season.



**FIGURE 200.** More typical dark color, this male *G. veletisoides* from Fresno Co., CA (S03-21).

**DNA.** Multilocus G568 first generation Los Gatos, S06-30 (type locality, collected 10-v-2006); and G3334 second generation Santa Cruz, S15-120 (collected 13-ix-2015) map (Gray *et al.* 2019) nearest to *G. chisosensis* and Clades 2 and 3 of *G. montis*, and distant from *G. veletis*. Despite their similarity, *G. veletis* and *G. veletisoides* are not close relatives within the North American *Gryllus*. Genetic similarity using Tamura-Nei distances for ITS2 was  $96.7 \pm 2.66$  within *G. veletis* ( $n = 25$  from across both *G. veletis* ITS2 clades, see *G. veletis* description and Discussion), and  $99.9 \pm 0.08$  within *G. veletisoides* ( $n = 10$ ), but only  $88.9 \pm 0.27$  between species.

**Discussion.** Along with *G. brevicaudus* and *G. lineaticeps*, the earliest singing field cricket in the San Francisco Bay area. Populations of *G. veletisoides* can have high densities.

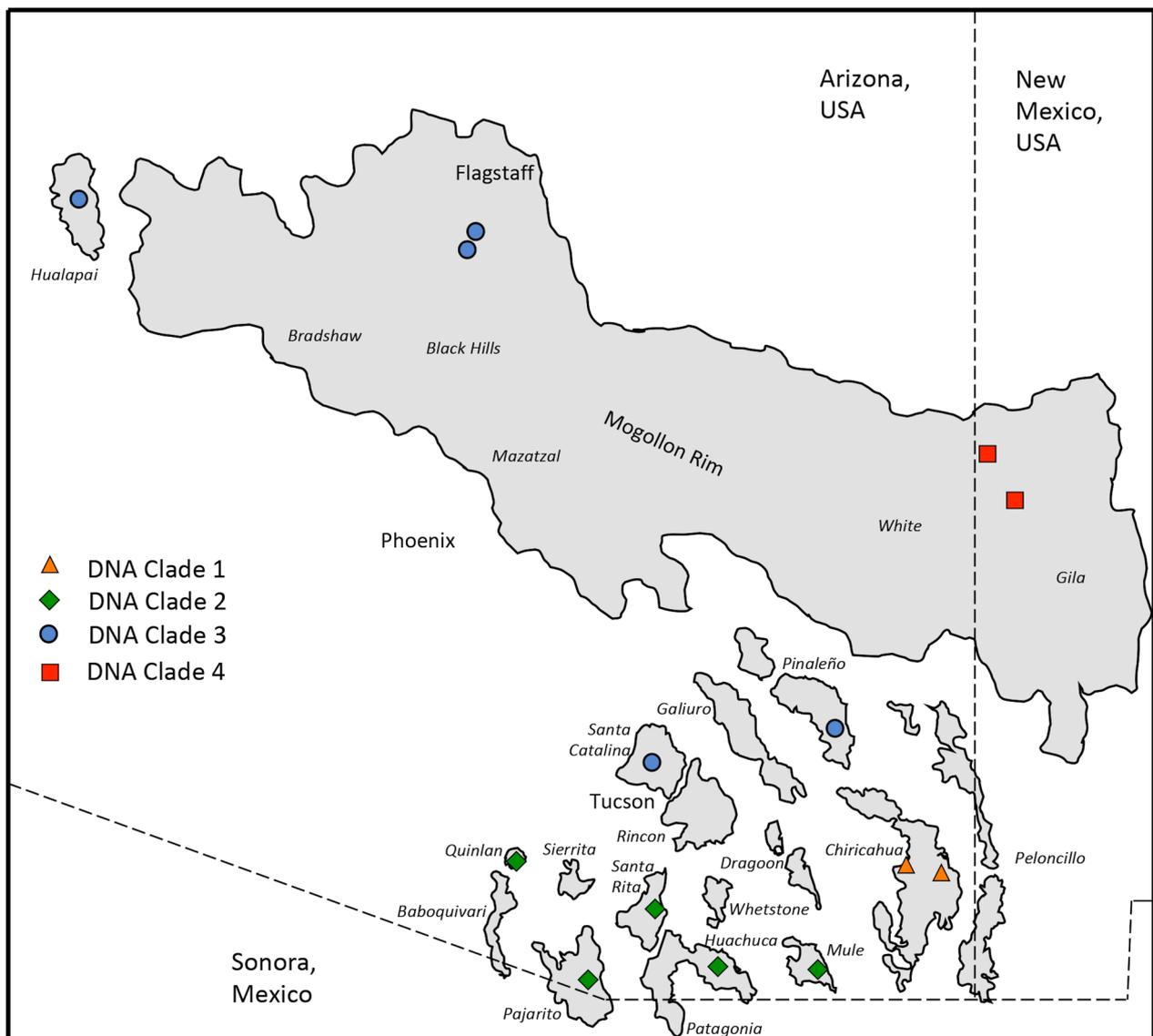
Preliminary hybridization studies conducted in 2003 between California virgin *G. veletisoides* and virgin *G. veletis* from the Midwestern US, before we had genetic data, produced the following results: 3 females from Indiana crossed with Fresno, CA, males—two females had documented matings (with visible passed spermatophores) but only one of these two female laid eggs. The third female also laid eggs. No eggs from any female hatched. One female from Illinois mated with a Fresno, CA, male and laid eggs but none hatched. One female from Iowa matched

with a male from Los Gatos, CA, laid eggs (never saw a passed spermatophore) but none hatched. Thus, from eggs laid by four Midwestern females, no eggs hatched. As controls, an Indiana female mated with a North Dakota male produced lots of eggs that hatched while a North Dakota female that mated with an Illinois male produced eggs that didn't hatch.

## The Montis Group

*G. montis* Weissman & Gray, n. sp.

An almost certainly polyphyletic grouping of four genetic clades of chirping crickets which are all found under tree cover in mountainous regions of the Southwestern US (Fig. 201). They remain indistinguishable to us except by DNA, which is why we have lumped them together as a single "Group." We discuss the characteristics and distributions of all four DNA Clades here, but we note that DNA Clade 4 is phylogenetically a stand-alone entry related to the Saxatilis Group. The relationships among DNA Clades 1-3 are not consistently resolved by 16S and ITS2, and also vary based on which analysis is applied to the multilocus data (Gray *et al.* 2019). In all cases, song is typically a slow chirp with four-pulses per chirp (Fig. 202).



**FIGURE 201.** Known distribution of *G. montis*, with locality coding based on multilocus DNA Clade.