

sult in the rapid hatching of such eggs and the appearance of second generation adults in late summer. But for eggs laid in the field, where Southwestern US monsoon rains typically first arrive in July and August, there may not be adequate time for second generation adults to appear before the arrival of cool fall temperatures, if egg development only first starts with the arrival of moisture. We suspect that if the first rains arrive in July, there will be enough time for some second-generation adults, although their contribution to the following year's population is unknown. What is apparent from the laboratory data is that since many nymphs from first-generation adults grow slowly, there will still be many individuals overwintering as late instars even in years with early July monsoon rainfall. Such a range of maturation dates results in flexibility, depending on rainfall and temperatures, within the population: early hatching would give the nymphs a chance to mature the same summer rather than overwintering as late instars and becoming adults the following spring. We would also like to see research into how long *Gryllus* eggs can remain viable in dry soil, since one predicted result of climate change is increased droughts in certain areas. This information may be particularly relevant in the Southwestern US since Hinton (1981, p. 177) notes that among insects "there are no kinds of eggs that will enter a state of cryptobiosis (i.e. reversible standstill of metabolism) by dehydration at physiological temperatures." Also, do crickets in areas with monsoon rains have more variable instar development than those in California with its predictable summer drought periods and a Mediterranean climate—rainfall regime?

**Variation. Color:** Three 2017, laboratory maturing adult females with a light colored, central, longitudinal belly strip that darkened post-mortem. **Tegmina:** One 1994, laboratory maturing female with tan tegmina.

**DNA.** Eight males and one female of *G. sotal* were sequenced for ITS2, and yielded 2 clades at the type locality (S15-77 & S17-4) (Fig. 209): 4 males and 1 female (G3493, G3497, G3503, G3505, G3508) were in Clade 1, more similar to *G. transpecos*; and 4 males (G3295, G3509, G3510, G3511) were in Clade 2, more similar to *G. lightfooti*. We suspect that this may be an artifact of poor alignment of ITS2 data (see general DNA discussions, pp 14 & 16). Multilocus sequence data (Gray *et al.* 2019), including individuals from each *G. sotal* ITS2 clade, suggests that *G. sotal* is genetically cohesive and most closely related to frequently arboreal *G. lightfooti* and terrestrial *G. transpecos*.

**Discussion.** On arrival, between 17:00 and 17:30, at the type locality in 2015 and 2017, males heard singing from sotal plants despite bright, sunny, warm weather. The plants with the most singers were those with live blades near the top but with dead flower stalks and dead skirts on lower three to four feet. Breaking off such plants at ground level and pounding the main stalk on open ground resulted in individuals being thrown onto the ground. Displaced individuals quickly attempted, many times successfully, to jump back into the plant being beaten.

We heard probable *G. sotal* males singing some 90m lower (32° 23' 14.05" -106° 33' 4.83") off Aguirre Springs Road but none could be collected, despite repeated attempts, with oatmeal trails, over several years. Once into more open and dryer Chihuahuan Desert at 1536m, where we found *Yucca elata*, no *Gryllus* crickets, including *G. lightfooti*, were heard. The time was 22:25 and the air temperature was 15.6°C, so the locality should be rechecked later in the season since mid-May, 2017, may be too early for singing *G. lightfooti*.

Oatmeal trail most productive where sotal plants occurred. In fact, this technique was much more successful than collecting later in summer when most of population is adult because, during the latter period, adult males seldom wander and infrequently come to oatmeal trails. Much greater success comes from collecting late instars and raising them to adult, especially at this site where collecting of singing adult males is extremely difficult due to their calling from impenetrable locations under, and within sharp, succulent sotal plants.

This is one of only 2 *Gryllus* commonly associated with an arboreal habitat, and both it and *G. lightfooti* are sister species [Note: several other species do occasionally climb vegetation, and that occurrence is noted under each respective taxon.]

### ***Gryllus transpecos* Weissman & Gray, n. sp.**

Texas Trans-Pecos Field Cricket

Figs 207–209, 216–221, Table 1

'G. #16' and 'G. #24' of DBW notebooks.

**Distribution.** Only known from western Texas between the Rio Grande River and the Pecos River.

*Recognition characters and song.* Medium to large sized, wide head and pronotum, always short hind winged, female tegmina only cover  $\frac{1}{2}$  to  $\frac{3}{4}$  of abdomen, cerci in situ typically extend beyond tip of ovipositor. Overall color black (Fig. 216) except for inside of hind femur which is reddish. *Song* (Fig. 217, R09-93) a slow chirp of 4–5 (range 3–7) p/c, CR usually 80–150, PR 20–30 at 25°C. Closely related and similar to both *G. lightfooti* and *G. sotol*. Separated from *G. lightfooti* by, in *G. transpecos*, cerci in situ typically longer than ovipositor tip, female tegminal bars usually absent (Fig. 216), associated with rocks (vs. open grasslands), small but consistent ITS2 DNA differences (Fig. 209), and not known to climb into vegetation to sing. The two taxa could overlap in far western Texas, although no such locality presently known. From Van Horn Pass, where *G. transpecos* is common, to the town of Van Horn (S91-48), where *G. lightfooti* occurs, is some 4 miles distance. The allopatric, Organ Mts., NM, endemic and closely related, *G. sotol* (Table 1, p. 18) has more file teeth, higher tooth density, shorter cerci never as long as ovipositor tip (typically longer in *G. transpecos*), slower PR, and different habitat: open, lower elevation, drier, rocky Chihuahuan Desert for *G. transpecos* versus higher, cooler, low mountain bajadas and woodlands, with sotol (*Dasyilirion wheeleri*), for *G. sotol*. Additionally, *G. sotol* frequently climbs into sotol while *G. transpecos* is found on the ground, or sometimes on rocky cliff faces in road cut areas.



**FIGURE 216.** Holotype male (left) of *G. transpecos*. Female (right) also from Big Bend National Park (S07-37) near type locality.

There are four other slow chirping, frequently rock-associated *Gryllus* species in the Trans-Pecos area that *G. transpecos* must be distinguished from. These four are not closely related to *G. transpecos* and can be separated by DNA (16S, ITS2, and multilocus data). Combinations of morphological, ecological and song characters are also diagnostic, as follows. From sometimes sympatric (at Van Horn Pass and Davis Mts.) *G. longicercus*: *G. transpecos* is distinguished by its larger head, broader pronotum, shorter cerci, lower tooth count and higher pulse rate. From almost sympatric (Davis Mts.) *G. veletis*: *G. transpecos* with longer cerci and different habitat (never in grassland). From sometimes sympatric (Davis Mts., S15-61) *G. planeta*, separated by 5 mostly non-overlapping physical characters (Table 1, p. 18): *G. planeta* has fewer number of teeth and shorter file length, cerci length, tegminal length and tegminal width, and faster chirp rate. From sometimes sympatric (at Big Bend, S85-55) *G. chisosensis*, they are separated by no overlap in number of teeth and PR and minor overlap in teeth/mm and cerci length. The two taxa are

also separated by microhabitat in that *G. chisosensis* prefers rocky areas of many rock layers (e.g. talus slopes) while *G. transpecos*, while preferring rocky habitats like rocky road cuts, is not associated with extensive piles of rocks.

From other allopatric, widespread, more western and unrelated, slow chirping US *Gryllus*, *G. transpecos* is separated from *G. montis* which has shorter cerci, narrower head and pronotum, earlier appearance of adults, different habitats (latter almost always with an overhead tree canopy), and longer ovipositor (Fig. 218).

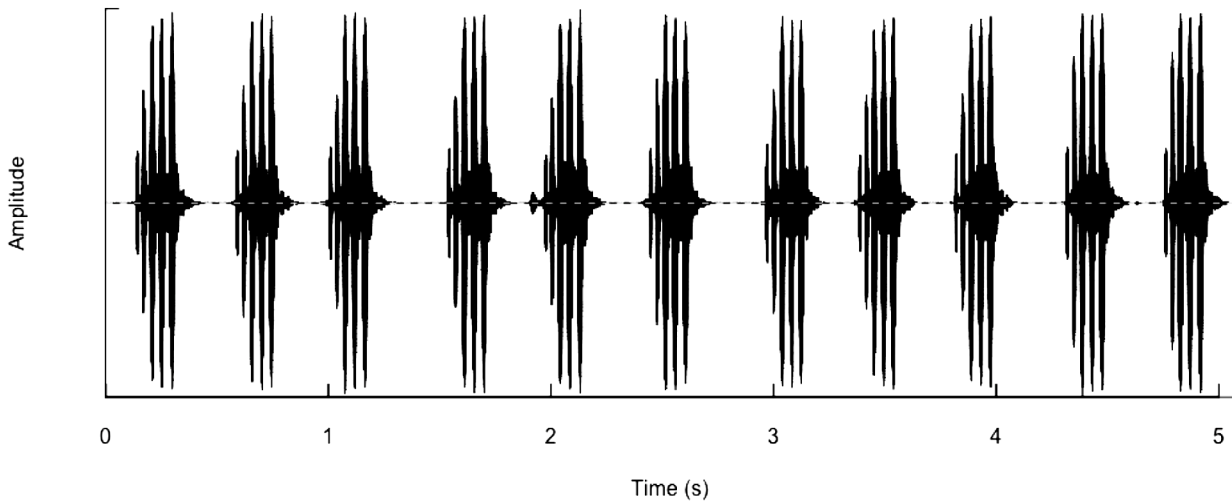


FIGURE 217. Calling song (R09-93) of *G. transpecos* from Culberson Co., TX (S09-64), recorded at 25°C.

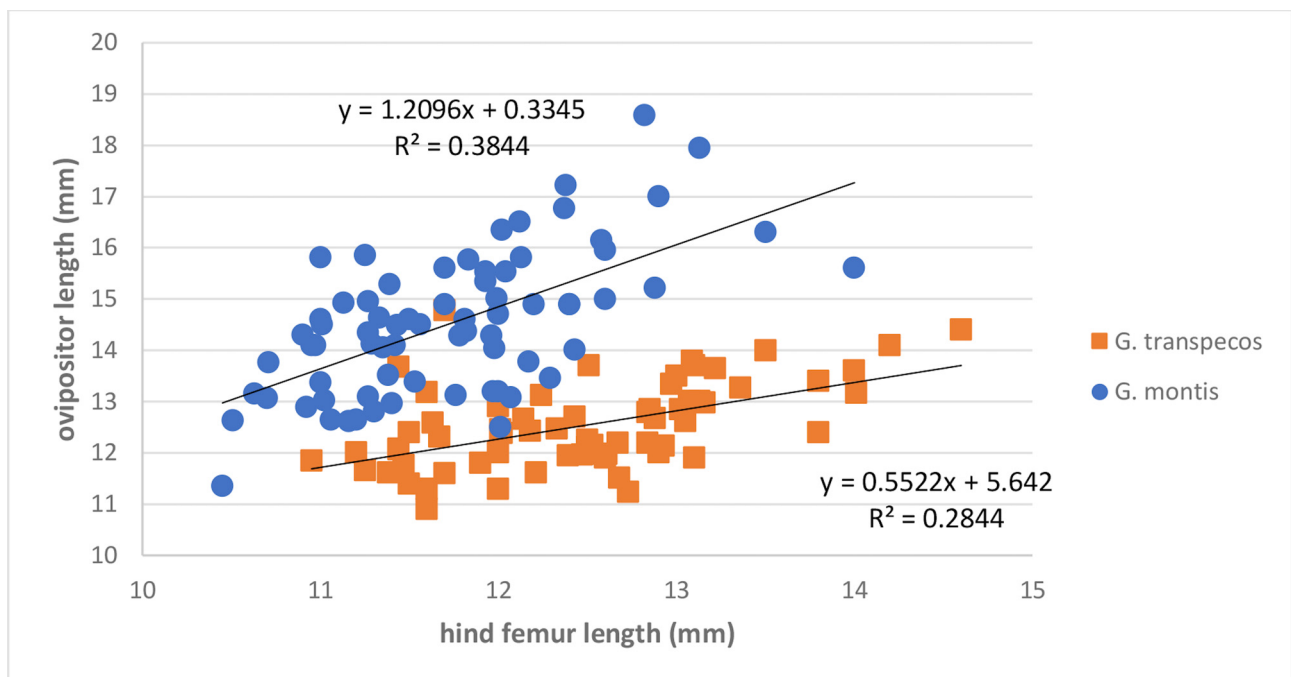


FIGURE 218. Regression hind femur length vs. ovipositor length in *G. transpecos* vs. *G. montis*.

Separated by 800 km from more western *G. saxatilis* which has longer tegmina and longer ovipositor, different multilocus (Gray *et al.* 2019), 16S, and ITS2 (Fig. 209) DNA.

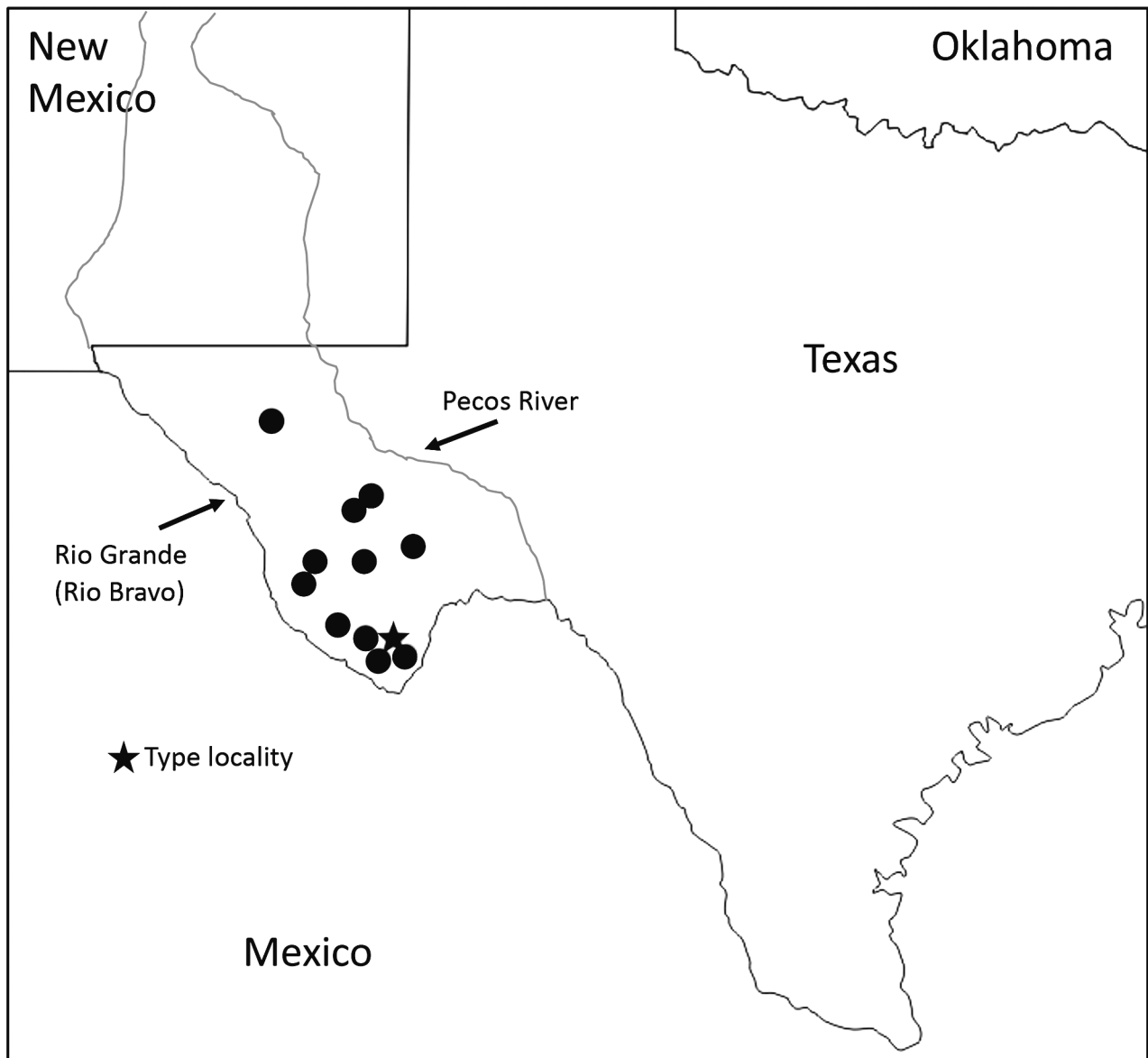
*Holotype*. Male (Fig. 216). USA, Texas, Brewster Co., Chisos Mts., Big Bend National Park, Grande Village Road to Ranger Station near Lost Mine Trail parking lot, 1.5 m NW ranger station, 12-vi-2007. 5500', 29° 16.471' -103° 17.211'. D.B. Weissman & D.C. Lightfoot. S07-36, R07-95, G1175. 16S ribosomal RNA GenBank accession # MN136663. BL 19.49, HF 12.13, LC 12.36. Right tegmen removed: 142 teeth, file length 3.8, TL 11.9, TW 5.2. Deposited CAS, Entomology type #19273.

*Paratypes*. (Total: 105♂ 76♀). **Texas**, Brewster Co., Chisos Mts., Big Bend National Park, 5500', type locality, 8-

vi-1985 (S85-55) 13♂ 6♀; 5-vi-1991 (S91-41) 11♂ 7♀; 12-vi-2007 (S07-36) 2♂ 1♀; Panther Junction, 3734', 12-vi-2007 (S07-38), 2-vii-2015 (S15-68) 3♂ 3♀; 18.7 m SE Panther Junction, 9-vi-1985 (S85-57) 1♂; 5-vi-1991 (S91-42) 1♂; Maverick Rd., 3756', 2-vii-2015 (S15-69) 2♂; Rio Grande Village, 2100', 9-vi-1985 (S85-56) 4♂ 1♀; 5-vi-1991 (S91-43) 2♂; Grande Village Road 4.5 m NW ranger station, 4340', 12-vi-2007 (S07-37) 1♂ 3♀; 28-v-2016 (S16-12) 1♂. Hwy 118 24 m S Alpine, 4434', 2-vii-2015 (S15-72) 7♂ 10♀. Hwy 170 8 m W Terlingua, 3000', 27-v-2016 (S16-10) 1♂. Hwy 385 3.3 m S Marathon, 4050', 28-v-2016 (S16-14) 2♂ 1♀. Culberson Co., Van Horn Pass area, 4880', 31° 03' 17.0" -104° 57' 04.4", 12-vi-1985 (S85-65) 6♂ 4♀; 6-vi-1991 (S91-47) 11♂ 11♀; 29-vi-2009 (S09-64) 10♂ 3♀. Jeff Davis Co., Davis Mts., Observatory, 6747', 1-vii-2015 (S15-61) 4♂ 1♀; 2.9 road m below Observatory, 6010', 1-vii-2015 (S15-64) 1♂ 2♀; 3.2 road m below Observatory, 5935', 1-vii-2015 (S15-65) 5♂ 5♀. Presidio Co., Chianti Mts., Hwy 67 Shafter, 3880', 27-v-2016 (S16-3) 4♂; 0.5 m N Shafter, 3856', 27-v-2016 (S16-2) 7♂ 15♀; 2.3 m S Shafter, 26-vi-1986, 3900' (S86-45) 3♂ 2♀. Hwy 170 E. Presidio, 2680', 27-v-2016 (S16-7) 1♂ 1♀. Hwy 170 39 m W Terlingua, 2660' 27-v-2016 (S16-8) 1♂; 30 m W Terlingua, 2600', 27-v-2016 (S16-9) 1♂.

*Derivation of name.* Trans-Pecos was originally defined, in 1887, by Texas geologist Robert T. Hill, as that portion of Texas west of the Pecos River, which perfectly describes the distribution of this species.

*Geographical range.* (Fig. 219). Apparently absent from ecologically similar areas of the Guadalupe Mts., Culberson Co., Texas, where we found (S01-63, 64, 65) slow chirpers *G. longicercus* and *G. lightfooti* at lower, dryer elevations, and *G. veletis* at higher (1920m), more mesic Dog Canyon.

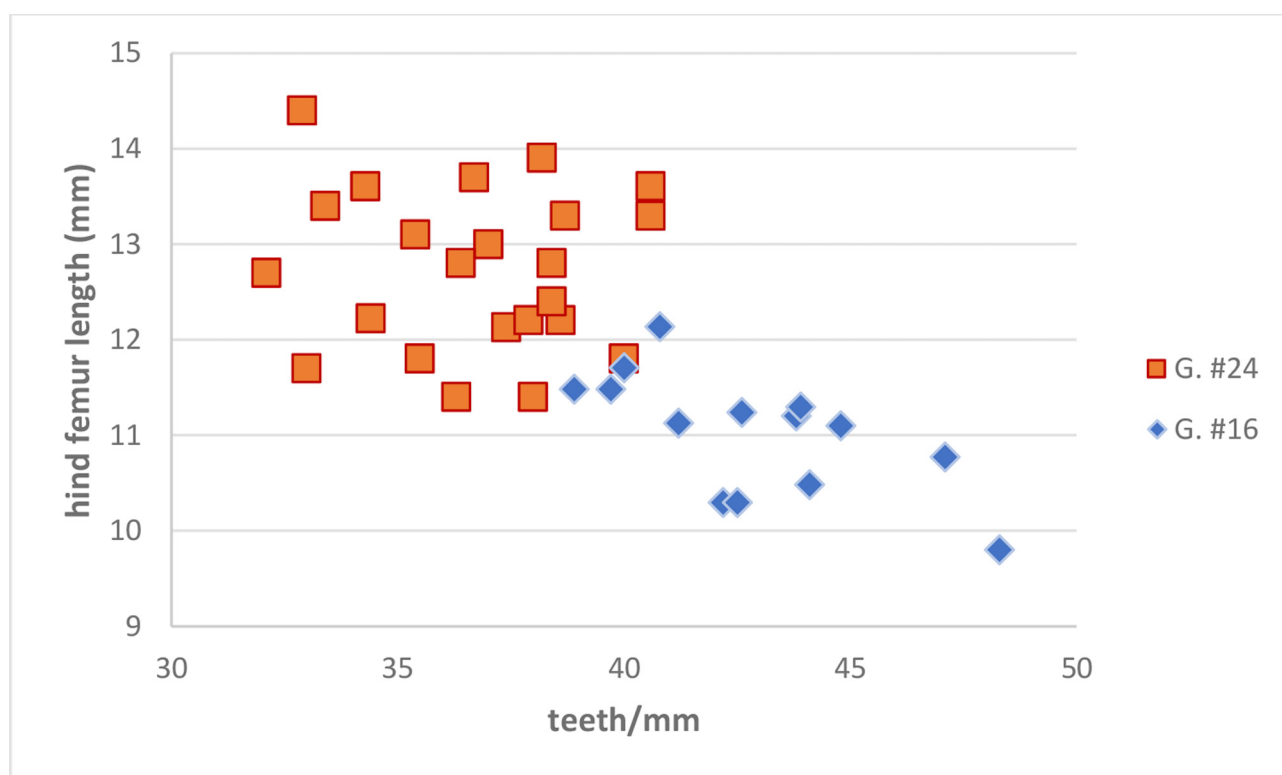


**FIGURE 219.** Known distribution of *G. transpecos*.

*Habitat.* Rocky road cuts (S16-2, 16-4); Piñon-juniper-oak woodland (S07-36); Chihuahuan Desert (S07-37) with *Acacia*, *sotol*, and *Yucca*; and natural, rocky slopes in and around towns (S16-3). Males sing from crevices, holes, under small plants, and under and around rocks. Not known from within any town, where *G. lightfooti* can frequently occur. *G. transpecos* appears to be the ecological equivalent of more western *G. saxatilis*.

*Life cycle and seasonal occurrence.* No egg diapause: Big Bend (S85-55 and S85-56), Van Horn (S85-65). Probably one generation/year. No nymphs seen at any Brewster Co. locality but most of population south of Shafter (Presidio Co., S86-45) penultimate or last instar when collected on 26-vi-1986.

*Variation.* Specimens from Big Bend National Park (our ‘G. #24’) are larger than those from Van Horn Pass (our ‘G. #16’) (see Table 1, p. 18) and this caused us some initial confusion. Individuals from these two localities differed in temperature corrected pulse rate, with #16 slower than #24 ( $21 \pm 0.4$  p/s versus  $24 \pm 0.4$  p/s;  $F_{2,22} = 12.02$ ,  $P < 0.001$ ); males differed in teeth/mm vs. hind femur length (Fig. 220;  $F_{2,30} = 5.5$ ,  $P < 0.01$ ) and tegmina width vs. hind femur length (Fig. 221;  $F_{2,30} = 7.4$ ,  $P < 0.01$ ). There was no difference in chirp rates, pulses/chirp, or dominant frequency. However, with the addition of individuals from areas other than these two localities, these significant differences disappeared, and we currently attribute this variation mostly to differences in body size, which is consistent with the linear relationships seen in both regressions—i.e. larger crickets have larger body proportions.

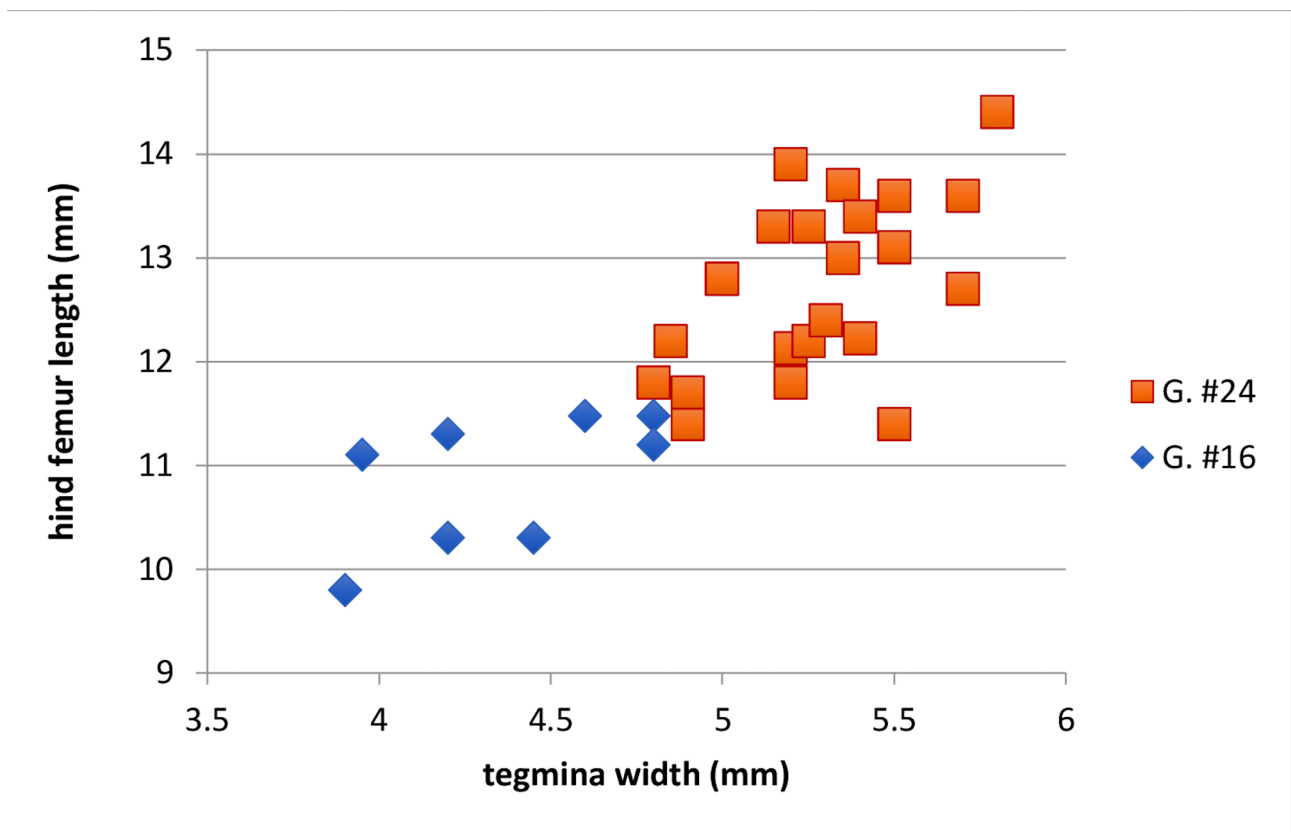


**FIGURE 220.** Regression of teeth/mm vs. hind femur length in *G. transpecos* populations from Big Bend National Park (‘G. #24’) vs. Van Horn Pass (‘G. #16’).

*DNA.* Multilocus G3062 Big Bend National Park (S15-68) and G3083 Davis Mts. (S15-61) sister species of *G. sotol* and *G. lightfooti* (Gray *et al.* 2019). We note that our confusion re. G. #16 and G. #24 (see above) was compounded by the fact that early 16S sequencing of *G. transpecos* yielded 3 separate clades comprised of individuals from 5.3 km south Marathon (S16-14), individuals from 38.6 km south of Alpine (S15-72), and individuals from Van Horn Pass (S09-64). Subsequent ITS2 sequencing showed these same individuals, from all three sites, to cluster together (Fig. 209, p. 207), hence our combining them together under *G. transpecos*.

*Discussion.* Can be a relatively common field cricket where found. Singing males easy to approach but stop singing once turning over rocks near them, as opposed to many males of *G. longicercus* that continue to sing while “their” rocks being turned over. Can sing all night and into early morning in Big Bend (S85-55, at 08:30).

Tinkham (1948) discussed the Orthopteran and faunistic zones of the Big Bend Region.



**FIGURE 221.** Regression tegmina width vs. hind femur length in *G. transpecos* populations from Big Bend National Park ('G. #24') vs. Van Horn Pass ('G. #16').

### The Longicercus Group

*G. longicercus* Weissman & Gray, n. sp. and *G. vulcanus* Weissman & Gray, n. sp.

Sister species of field crickets with exceptionally slow pulse rates within chirped song (Figs 222, 223). *G. longicercus* is widespread in the Southwestern US hotter desert regions; *G. vulcanus* is a morphologically similar, but smaller, cricket restricted to two lava flows in New Mexico. ITS2 does not separate the taxa (Fig. 224); whether or not this is due to incomplete lineage sorting, given a recent derivation of the lava-endemic *G. vulcanus* from *G. longicercus*, or because *G. vulcanus* is simply *G. longicercus* as found on lava, is not entirely clear.

#### *Gryllus longicercus* Weissman & Gray, n. sp.

Long Cercus Field Cricket

Figs 206, 222–229, 232, 233, Table 1

'Gryllus #13' of DBW notebooks.

'*G. longicercus*' of Gray *et al.* (2016a).

**Distribution.** Southwestern states of Arizona, New Mexico, and Texas, with minor extensions into California, Utah, and Colorado.

**Recognition characters and song.** A medium to large, usually short hind winged cricket with the longest known cerci in the genus, sometimes exceeding the body length of pinned specimens (male from Kofa [S88-88, R88-172]). Intact cerci always considerably longer than ovipositor in situ (except for individuals from Tijeras Canyon, NM, S19-35). File teeth from ~170–220 (range 155–231). Almost always associated with rocks. **Song** (Fig. 225, R15-159) a slow to medium fast chirp with 4–5 (range 3–6) p/c, PR usually from 9–12 with individual pulses distinguishable