

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

by ear and almost countable at 25°C. While *G. longicercus* can occur microsympatrically with several other slow chirping, rock loving, medium to long length cerci, western US *Gryllus*, its low PR makes them immediately identifiable in the field. Morphologically most similar to *G. chisosensis* but the latter, with its unique DNA, restricted to the Chisos Mountains in Big Bend, TX, where *G. longicercus* doesn't occur (nearest population of *G. longicercus* is in the Chinati Mountains, just south Shafter [S16-4] and ~115 km from nearest population of *G. chisosensis*). Microsympatric with the Organ Mountains' endemic *G. sotol* at Aguirre Springs, New Mexico, but separated by non-overlapping pulse rate, DNA, and fewer file teeth in the latter. Morphologically similar to *G. leei* but the latter, only on lava flows in Utah, separated by non-overlapping PR (lower in *G. longicercus*), almost non-overlapping tooth count (higher in *G. longicercus*) and DNA (Gray *et al.* 2019). Also, morphologically similar to *G. vulcanus* but the latter, only on lava flows in New Mexico, is a smaller cricket with fewer teeth, shorter tegmen, shorter cerci, and shorter ovipositor (Table 1, p. 18). Microsympatric with *G. transpecos* but separated by non-overlapping PR (lower in *G. longicercus*) and almost non-overlapping tooth count (higher in *G. longicercus*). Comparing females of *G. transpecos* from Van Horn, TX (S85-65, S09-64) with microsympatric *G. longicercus*, ovipositor in latter shorter than in former despite larger body size (can also separate female *G. transpecos* from female *G. longicercus* because of cerci length in *G. transpecos* are as long as or just longer than the ovipositor in situ). Frequently microsympatric, in road cuts, with *G. lightfooti*, but separated by non-overlapping PR (lower in *G. longicercus*) and almost non-overlapping tooth count (higher in *G. longicercus*). Also, females of *G. lightfooti* difficult to distinguish although the latter usually have a tegminal bar vs. solid black tegmina in *G. longicercus*. Only known to be microsympatric with the more western, slow chirping, rock loving *G. saxatilis* in the Hualapai Mts., Mohave Co., AZ (S90-56), but the two species both occur in Washington Co., UT and could also be sympatric in south-eastern CA around Anza Borrego, San Diego Co. In such localities, the 2 taxa would still separate by pulse rate and DNA.

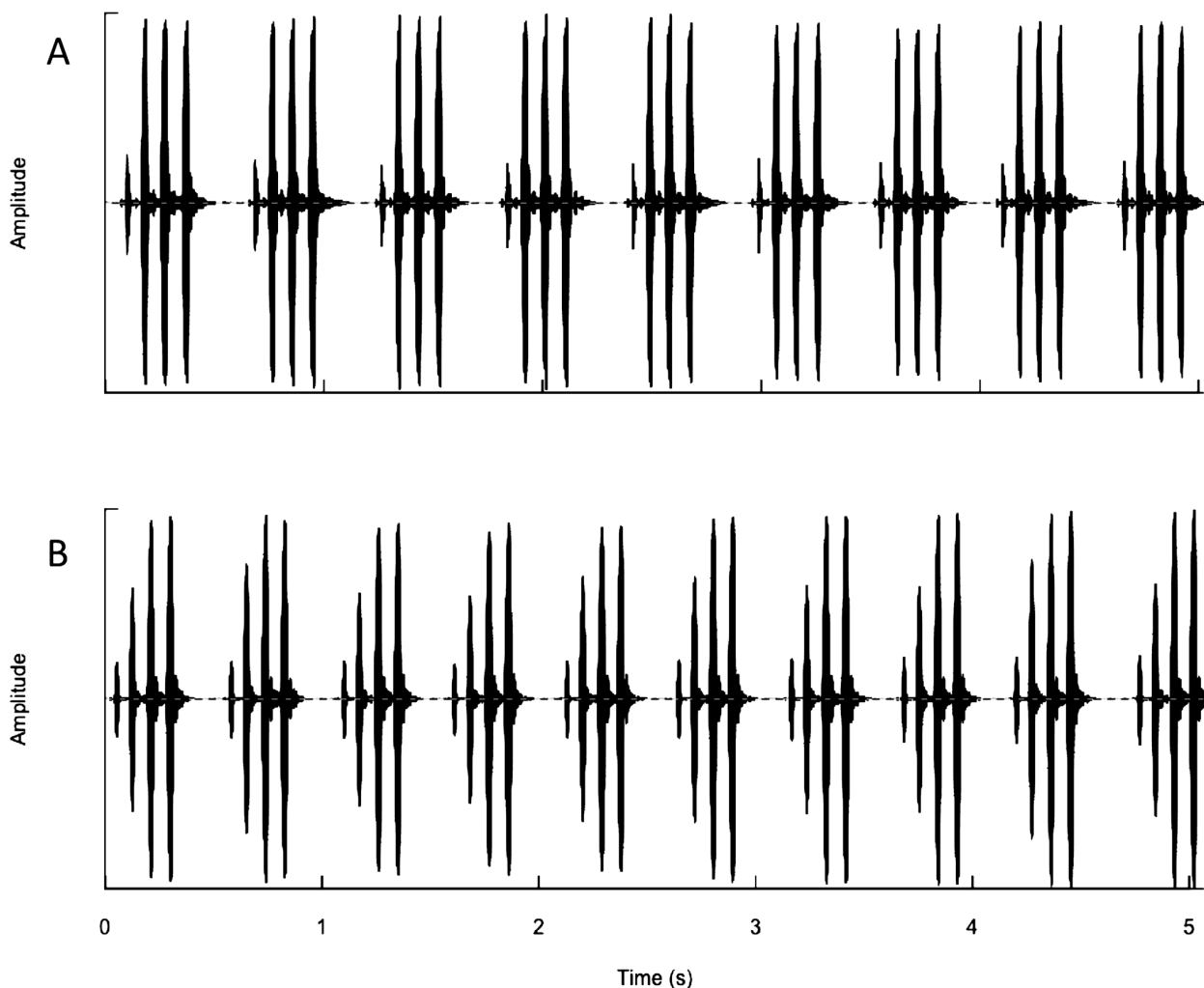


FIGURE 222. Five second waveforms of typical calling songs of (A) *G. longicercus* and (B) *G. vulcanus*. (A) *G. longicercus*: (R15-159) Torrance Co., NM (S15-52), at 25.3°C; (B) *G. vulcanus*: (R07-68) from type locality, at 25°C.

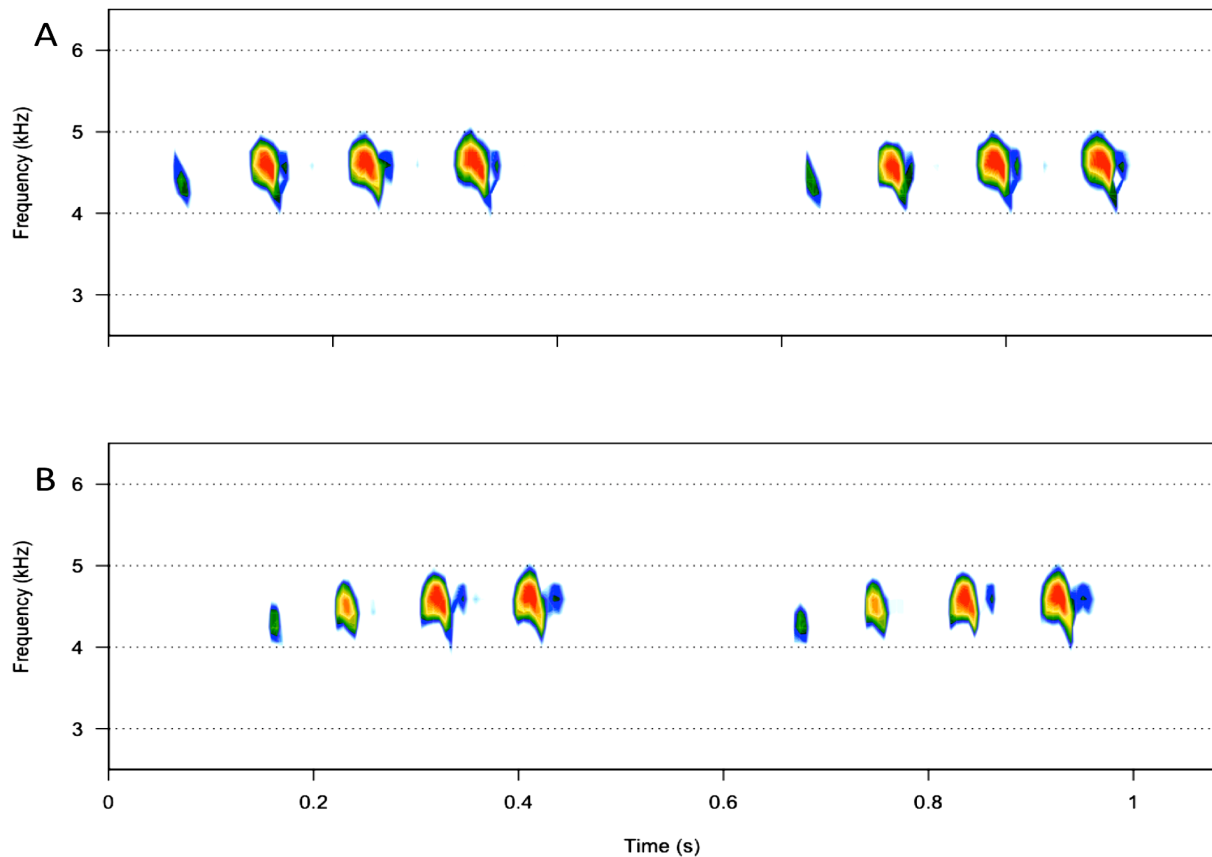


FIGURE 223. One second spectrograms of typical calling songs of (A) *G. longicercus* and (B) *G. vulcanus*, same males as in Fig. 222.

Holotype. Male (Fig. 226): Arizona, Yuma Co., Kofa National Wildlife Refuge, Palm Canyon, 16-ix-2011; molt to adult 25-x-2011. 2100'. 33° 21' 37.8" -114° 06' 22.2". D.B. Weissman, D.W. Weissman. S11-93, R11-185, BL 19.06, HF 11.86, LC 16.48. Right tegmen removed 217 teeth, file length 4.3, TL 13.7, TW 5.4. Type deposited in CAS, Entomology Type #19267.

Paratypes. (Total 217♂ 158♀). **Arizona**. *Cochise Co.*, Bisbee, 5500', 1-vi-2013 (S13-18) 2♂. Portal, 29-vii-1981 4770' (S81-37) 2♂. Chiricahua Mts., Fort Bowie, 4723', 2-vi-2013 (S13-19) 13♂ 6♀. *Coconino Co.*, Sedona, 15-vi-1990, 4400' (S90-49) 3♂ 2♀; 12-vi-1996, (S96-62) 5♂ 1♀. Hwy 89A 1 m S intersection with Hwy 179, 30-vi-1994, 4420' (S94-36) 4♂ 2♀. 2.6 m N Sedona, 25-vi-1980, 4600' (S80-43) 2♂ 2♀. *Gila Co.*, Coolidge Dam, 30-vii-1981, 2400' (S81-43) 1♂. *Graham Co.*, 7-10 m NW Bylas, 30-vii-1981, 2800' (S81-42) 1♂; 25-viii-1982 (S82-102) 8♂. Pinaleno Mts., Mt. Graham, 4-vii-1994, 5000' (S94-54) 5♂; 10-vi-2012, 5000' (S12-19) 2♂ 8♀. *La Paz Co.*, 18-35 m N Wenden on road to Alamo Dam, 23-vii-1990, 1200' (S90-70) 3♂ 1♀. *Mohave Co.*, Burro Creek Campground, 1960', 3-iv-2004 (2004-002) 1♂. Quartzsite, 26-vi-1980, 1000' (S80-46) 2♂. Kingman, 3-viii-1991 (S91-68) 1♂; 2-viii-1992, 3700' (S92-113) 1♂ 1♀. Road to Hualapai Mtn. Park SE Kingman, 19-vi-1990, 5000' (S90-56) 3♂ 2♀. *Pima Co.*, Ajo, 20-viii-1998, 1720' (S98-72 & S98-74) 9♂ 6♀; 17-ix-2011 (S11-99) 1♂. Hwy 85 13m N Ajo, 1255', 30-vii-2015 (S15-110) 1♂ 1♀. Baboquivari Mts., Brown Canyon, 31° 45' 37.0" -111° 31' 58.8", 3786', 29-vii-2015 (S15-105) 1♂ 5♀. Kitt Peak, Hwy 386 5.1 m from Hwy 86, 17-ix-2011, 4500' (S11-98) 2♂; Kitt Peak picnic area, 10.5 m from Hwy 86, 8-vi-2013, 6277' (S13-36) 3♂ 1♀. Near Sonora Desert Museum, 28-vii-1981, 2900' (S81-35) 5♂ 2♀. Organ Pipe Cactus National Monument Campground, 8-iv-2004, 1670' (2004-086) 1♂. Santa Catalina Mts., Mt. Lemmon Rec. Area, 27-vii-1990, 2900' (S90-83) 3♂ 2♀; 7-vii-1994, 3500' (S94-61) 1♂; 27-vi-2009, 4820' (S09-51) 1♂. 11-vi-2012, 4675' (S12-23) 10♂ 9♀. Tucson, 27-vii-1990, 2600' (S90-84) 1♂. Why, 20-viii-1998, 1740' (S98-71) 9♂ 5♀. *Santa Cruz Co.*, Madera Canyon, Bog Springs campground, 5010' 19-viii-2004, 6♀. *Yavapai Co.*, Hwy 179 on west side Sedona, 4000', 30-vi-2013 (S13-16) 4♂ 1♀. *Yuma Co.*, Telegraph Pass, 10-viii-1988, 600' (S88-90) 1♂; 17-viii-1998 (S98-62) 4♂ 2♀. Kofa National Wildlife Refuge, Palm Canyon, 10-viii-1988, 2050' (S88-88) 3♂; 4-vi-1989 (S89-26) 1♂ 6♀; 16-ix-2011 (S11-93) 10♂ 35♀. **California**.

San Bernardino Co., Providence Mts. State Recreational Area, 5-vi-1989, 4100' (S89-28) 2♂ 1♀. Havasu City, 6-vi-1983 (S83-62) 1♂. 14 m N Vidal, 6-vi-1983, 1200' (S83-63) 1♂. *San Diego Co.*, Road S22 from 2.7 to 10 m SW Borrego Springs, 8-viii-1988, 1800' (S88-81) 2♂. **Colorado.** *Las Animas Co.*, Trinidad Lake State Park, Carpios Ridge Campground, 6734', 29-vi-200, 1♂, JA Cole. **New Mexico.** *Bernalillo Co.*, Tijeras Canyon ~2 m W Tijeras, 6000-6600' (S19-35, S19-37, S19-38), 3-5-vii-2019, 9♂ 8♀, D.C. & K. Lightfoot. *Chaves Co.*, Hwy 380 7.3 m E Roswell at mile post 163.4, 28-vi-2009, 3960' (S09-59) 3♂ 5♀. Hwy 82 ~33 m W Artesia, 30-vi-2015, 4824' (S15-56) 7♂ 9♀. *Dona Ana Co.*, Organ Mts., Aguirre Springs Rec. Area, 24-vi-1985, 6500' (S85-93) 2♂; 17-viii-1993 (S93-70) 1♂; 3-vii-2015 (S15-77) 1♂; 19-v-2017 (S17-4) 1♂ 2♀. Tortugas Mts., near UNM, Las Cruces, 23-viii-1982, 4000' (S82-95 & S82-96) 2♂. *Sandoval Co.*, Jemez Pueblo, 22-viii-1982 (S82-90) 4♂ 2♀; 6-v-1985, 5600' (S85-50) 3♂. *Socorro Co.*, Los Pinos Mts., Goat Draw 4.5 m N Hwy 60, 16-viii-1993, 6440', 34° 22' 10" -106° 32' 0" (S93-69) 1♂. Hwy 60 34° 24' 12.07" -106° 30' 29.16", 29-vi-2015, 6004' (S15-53) 4♂ 4♀. Sevilleta National Wildlife Refuge, 15-viii-1993, 5145' 34° 24' 30" -106° 56' 43" (S93-66) 4♂ 4♀. *Torrance Co.*, Hwy 60 rocky road cut SW Mountainair, 29-vi-2015, 6037', (S15-52) 5♂ 2♀. **Utah.** *Washington Co.*, Springdale, 9-viii-1991, 4000' (S91-94) 1♂. 2 m E of west entrance to Zion National Park, 10-vi-1996, 4220' (S96-54) 4♂ 3♀. Just west of Zion National Park west entrance, 10-vi-1996, 4060' (S96-55) 1♂ 1♀. **Texas.** *Culberson Co.*, Guadalupe Mts., 4.4 km NE Pine Springs, 13-vii-2001, 5240' (S01-63) 9♂ 4♀. I10 8 m W Van Horn, mile post 133, 12-vi-1985, 4300' (S85-65) 3♂ 1♀; 29-vi-2009 (S09-64) 4♂. *Jeff Davis Co.*, Davis Mts., 30° 40' 8.73" -104° 02' 14.72", 6073', 1-vii-2015 (S15-63) 2♂ 3♀. *Presidio Co.*, Chianti Mts., Hwy 67 0.5 m N Shafter, 3856', 27-v-2015 (S15-2) 1♂ 1♀. Hwy 67 just S Shafter, 3920', 27-v-2016 (S16-4) 5♂ 1♀. *Randall Co.*, Palo Duro Canyon State Park, 12-vi-1988, 3600' (S88-37) 4♂ 1♀.

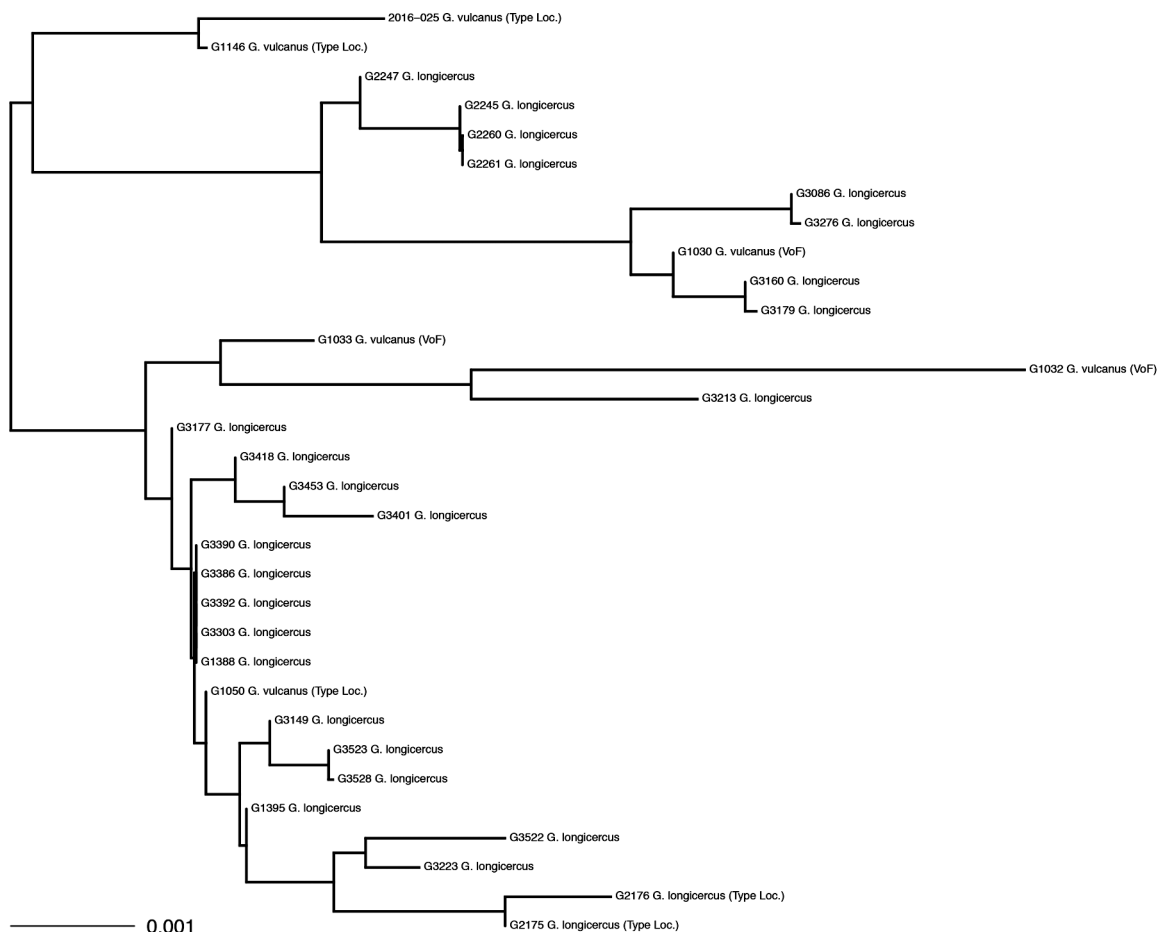


FIGURE 224. ITS2 gene tree. Collection stop numbers for *G. longicercus* samples: S09-64 (G1388, G1395); S11-93 (G2175, G2176); S12-23 (G2245, G2247, G2260, G2261); S15-52 (G3086, G3276); S15-56 (G3160, G3179); S15-63 (G3149, G3223, G3303); S15-77 (G3177); S15-110 (G3213); S16-2 (G3418); S16-4 (G3386, G3390, G3392, G3401, G3453); S17-4 (G3522, G3523, G3528). Collection stop numbers for *G. vulcanus* samples: S07-46 (G1030, G1032, G1033); S07-52 (G1050, G1146); type locality (2016-025).

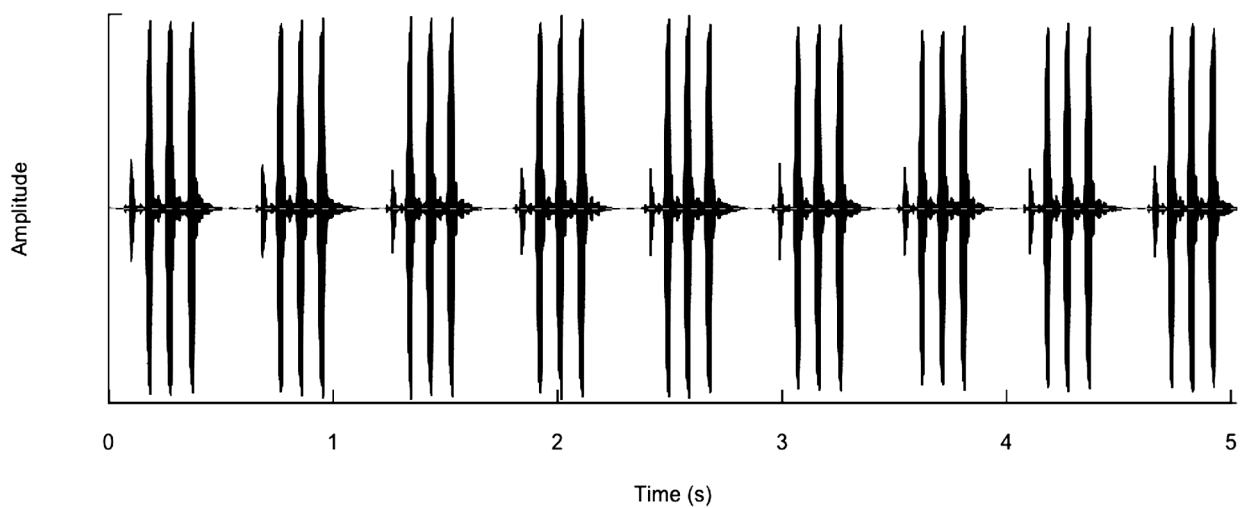


FIGURE 225. Calling song (R15-159) of *G. longicercus* from Torrance Co., NM (S15-52), recorded at 25.3°C.



FIGURE 226. Holotype male (left) of *G. longicercus*. Female (right) also from type locality (S89-26).

Derivation of name. In recognition of their long cerci, which sometimes exceed 19 mm (Ajo [S98-72] and Why [S98-71], Kofa [S11-93], AZ; Shafter, [S16-4], TX) in length and can be longer than body length of a pinned adult male (e.g. Kofa [S88-88]).

Geographic range. (Fig 227). Populations extend into Mexico.

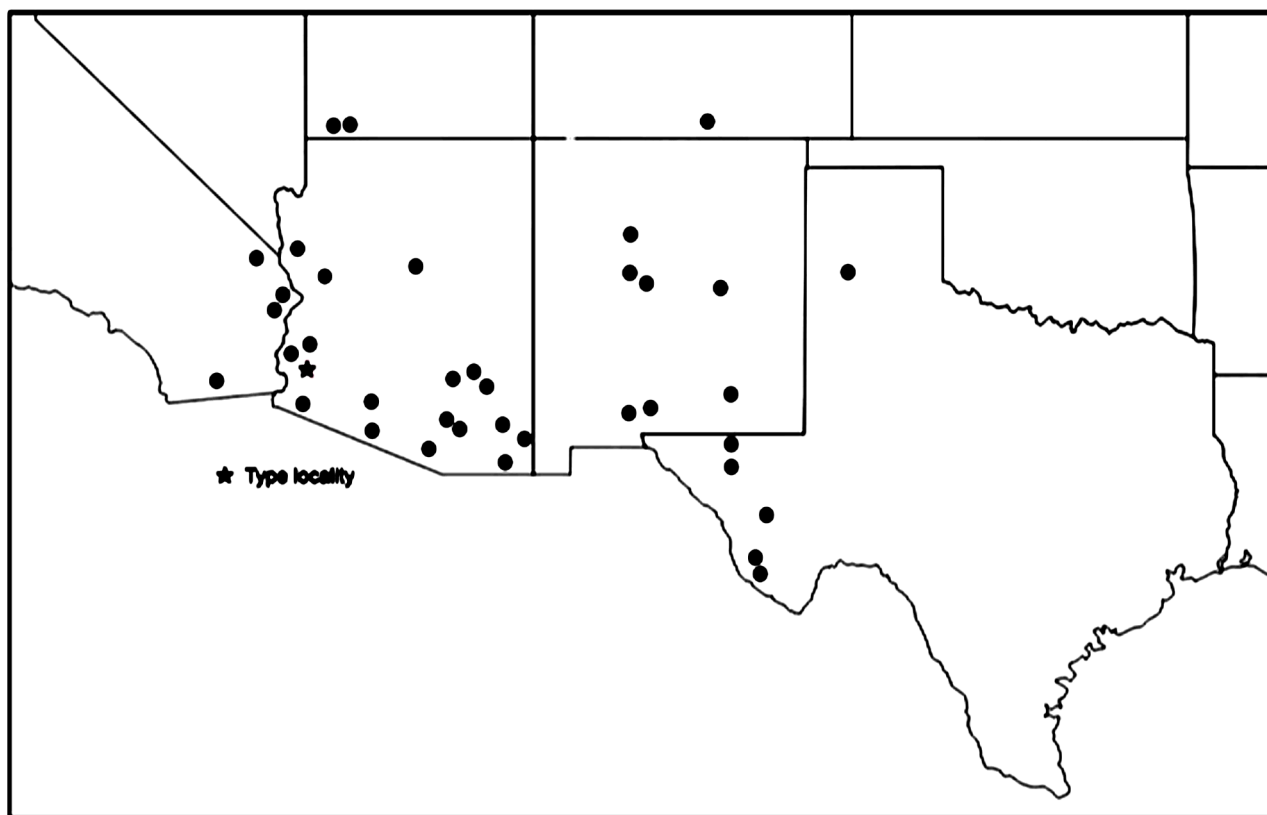


FIGURE 227. Known US distribution of *G. longicercus*.

Habitat. From 183m (Telegraph Pass, AZ, S88-90) to 1980m (Aguirre Springs, NM). Rocky washes, rocky canyons with Joshua tree, *Larrea*, cactus, and *Eriogonum*, oak-juniper grassland with rocks, rocky slopes with pinyon-juniper, rocky road cuts, on ground at base of walls and in cracks on walls and rocky talus slopes. Never found with solid overhead tree cover. Occasionally in towns like Kingman, AZ (S91-68). Also in town in Ajo in cracks at a gas station (S98-72). One male collected from sotol at Aguirre Springs, NM (S15-77), while searching for *G. sotol*.

G. longicercus appears to ecologically replace *G. saxatilis* as one moves east and south into the Sonoran and Chihuahuan Deserts of the Southwest US. Once into western Texas, *G. transpecos*, the ecological equivalent of *G. saxatilis*, can be sympatric with *G. longicercus*

Life cycle and seasonal occurrence. No egg diapause (S88-37). Probably two generations/year, at least at the type locality (Palm Canyon, Kofa National Wildlife Refuge). At the type locality, DAG collected a single adult female 18-iii-2005 (and heard calling males); 12 adult males and 2 adult females 15-iv-2010; a single adult male 5-iv-2013; a single adult male 7-ix-2013 (parasitized by the tachinid *Ormia ochracea*); 6 adult females and 2 late instar females 6-viii-2016 (and heard calling males). Similarly, DBW collected a few singing males there on 4-vi-1989 and saw many more late instars, which started molting to adults in early to mid-July. DBW collected apparent second-generation individuals (7 adult males, many adult females, and many late instars) on 16-ix-2011. Those late instars started molting to adult some 2 weeks later.

We have visited the Ajo/Why, Arizona, area four times after a collecting trip on 20-viii-1998, at which time we collected 15 individuals of *G. longicercus* and 5 other species of *Gryllus*. Our subsequent visits there were on 16-v-1999 (S99-26), 1-viii-2009 (S09-102), 17-ix-2011 (S11-99), and 29-vii-2015 (S15-109) and we only found *G. longicercus* singing during the last 2 visits, and then only one male each time. Apparently, rainfall has a significant effect on when certain species of Sonoran Desert field crickets appear.

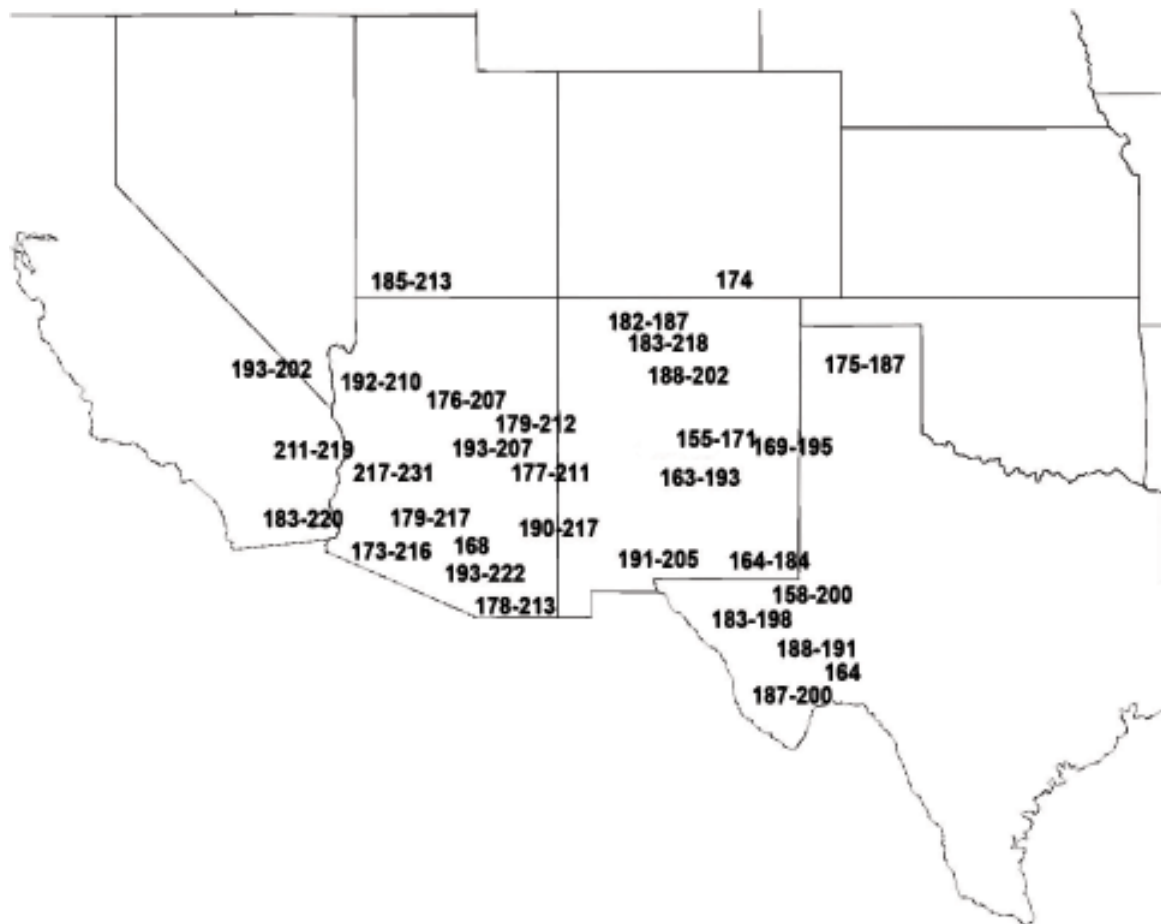


FIGURE 228. Map of *G. longicercus* file tooth counts showing geographic variation. Counts vary from 155 (Mountainair, NM, S15-52) to 231 (Quartzite, AZ, S80-46).

During June, Arizona field trips, we collected many more late instar nymphs than adults at the following localities: Mt. Graham (S12-19), Mt. Lemmon (S12-23), and Fort Bowie (S13-19).

Variation. Female tegmina length: The large series of 35 females from the type locality, where *G. longicercus* is usually the only field cricket present [highly flight-capable *G. staccato* also found there once, 15-iv-2010 (DAG 2010-017 female, 2010-018 male)], demonstrates a range from long (most specimens) tegmina almost reaching the tip of the abdomen to very short ones covering about $\frac{1}{2}$ of the abdomen. Both conditions are seen in other populations where several females have been collected. **Hind leg color:** In most specimens, entire hind leg is dark except for reddish area on inside of hind femur. All individuals from Washington Co., Utah, and near Roswell, New Mexico (S09-59), have the entire hind leg reddish colored. **Hind wing length:** Most field collected adults with short hind wings although many adults in towns of Ajo/Why, Arizona, with long hind wings. Additionally, over 70% of type locality late instar nymphs collected on 16-ix-2011 (S11-93) had long hind wings after molting to adult in the subsequent 2-4 weeks while all, simultaneously, field-collected adults from there were short winged. **Length of cerci in situ:** In *G. longicercus*, cerci usually considerably longer than ovipositor except for the high elevation (1830m) population from Tijeras Canyon, NM (S19-35), where the intact cerci in 4 females did not exceed the tip of the ovipositor. In fact, the two longest ovipositors in any females, from any population of this species, were from this site, perhaps indicating that the winters there are extremely cold. Two other females from 300m higher (S19-37) in the same area both had cerci longer than the ovipositor. **Number of file teeth:** Varies from 155-231 over its US range (Fig. 228), which is considerably more than the tooth range of 30-40 seen in most other *Gryllus* species. Significantly, a male from Mountainair, New Mexico (S15-52) with the fewest number of teeth (155) known for this species, sang (R15-341) with a pulse rate of 10.8 at 26°C. Both his 16S and ITS2 DNA mapped with other *G. longicercus*. Three other males from Mountainair had 162, 164, and 171 file teeth. **Song:** Male (Fig. 229A, R93-153)

from Sevilleta Refuge, NM (S93-66) with 7-9 p/c and PR 8.6. R09-112 (Fig. 229B) from Van Horn, TX (S09-64) with 9-30 p/c (most similar to a trill) and PR 11.8. **Overall population characteristics:** The population from 11.7 km E Roswell (S09-59) was unusual in several ways: (1) adults with brown-reddish heads compared with usual black heads. (2) Singing males were very wary and readily stopped singing when approached. They resumed singing only after much delay, even though air temperatures $\sim 22^{\circ}\text{C}$. (3) Males made no chirping noises as we turned over rocks trying to collect. In most cases, in most other populations, males continue to sing after they have climbed down into their rock pile while we are moving rocks aside to locate them. (4) These males jumped well and readily while we were trying to collect them. Multilocus analysis maps a male from there (S09-59) with individuals from the type locality of Palm Canyon, AZ (2016-039), and Shafter, TX (S16-4). **Tegminal markings:** rare males and females have a light tegminal bar.

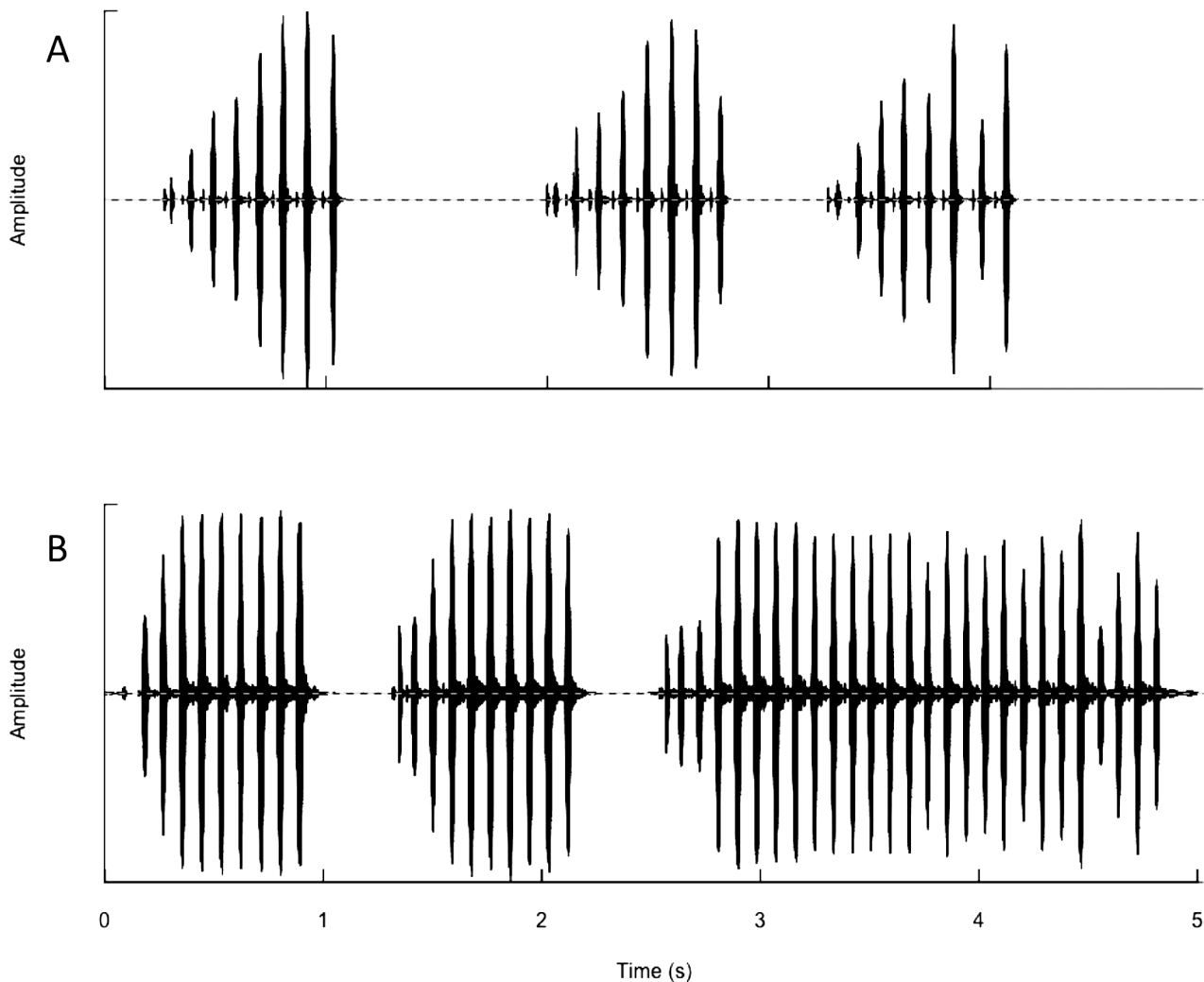


FIGURE 229. Atypical “trill” calling song of *G. longicercus*: (A) (R93-153) from Socorro Co., NM (S93-66), recorded at 22°C ; (B) (R09-112) from Culberson Co., TX (S09-64), recorded at 28°C .

DNA. Multilocus 2016-039 (Kofa, type locality of Palm Canyon); G1433, 7.3 m E Roswell, NM (S09-59); and G3386, Shafter, TX (S16-4) are sister species (Gray *et al.* 2019) to New Mexico lava restricted *G. vulcanus* 2016-025 from El Malpais; and G1030, from Valley of Fires State Park (S07-46).

Discussion. Behaviorally, most male *G. longicercus* continue chirping while turning over rocks attempting to capture them, a characteristic fairly unique to this taxon but also sporadically seen in other rock chirping species. Oatmeal trails do well to attract adult females and even some adult males. Adult males sometimes climb and sing: 1 male singing 1.5m up in shrub at Palo Duro Canyon State Park, TX (S88-37).

Of the 7 adult males (probably only two or three were actually singing) collected at the type locality of Palm

Canyon (S11-93) on 16-ix-2011, all were parasitized by the tachinid *Ormia ochracea*. Five males had 1 fly larva, one male had 2 larvae, and one male had 4 larvae. Of the many adult females and late instars of both sexes collected concurrently, none were parasitized. One of two males from Kitt Peak (S11-98) parasitized with one *Ormia ochracea* larva.

Late instars of *G. longicercus* have contrasting, banded abdomens, a common juvenile character of many species in the two rock-chirping groups: Longicercus Group and Saxatilis Group, and also seen in *G. lightfooti*.

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

New Mexico Lava Field Cricket

Figs 222–224, 230–235, Table 1

‘Gryllus #41’ in DBW notebooks.

Distribution. Known only from two lava flows in central New Mexico.

Recognition characters and song. A small to medium, always short hind wing, almost totally black (except for inside of hind femurs which can be reddish colored) *Gryllus* with medium length cerci longer than ovipositor tip in situ (Fig. 234), and a file tooth count greater than 160. *Song* (Fig. 230, R07-68) usually with 4–5 p/c (range 3–7), PR < 14 and pulses almost countable at 25°C. Distinguished from only other US obligate lava field cricket, *G. leei*, from Utah, in minimal overlap in number of teeth (Fig. 231, Table 1, p. 18), no overlap in pulse rate, and different DNA (Gray *et al.* 2019).

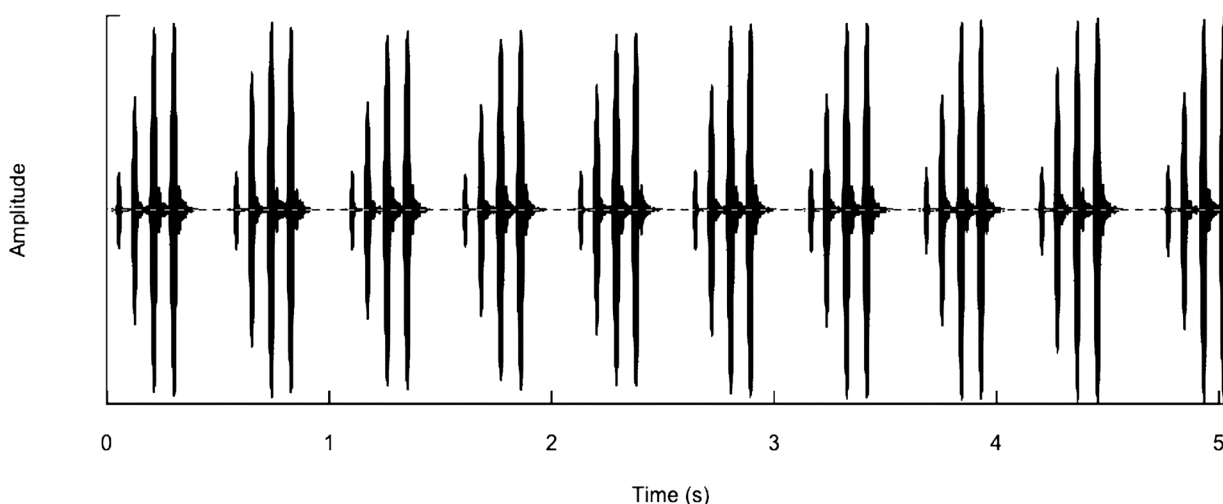


FIGURE 230. Calling song (R07-68) of *G. vulcanus* from type locality, recorded at 25°C.

Morphologically and genetically most similar to sister species *G. longicercus* but *G. vulcanus* matures earlier (despite being at higher elevation), is smaller with fewer file teeth (Fig. 232), shorter cerci, habitat (only on lava as opposed to rocky areas), and shorter ovipositor (Fig. 233).

From microsympatric, off-lava *G. veletis* at the type locality, the two taxa are easily separated (Table 1, p. 18) by cerci length and pulse rate.

Holotype. Male (Fig. 234). USA, New Mexico, Cibola Co., El Malpais National Monument adjacent to Hwy 117 at mile post sign 31 [or 31 m S I40], 14-vi-2007, 2161m. 34° 47' 17.16" -107° 56' 13.92" DB Weissman, DC Lightfoot, S07-52, R07-81 & 84, G1146. 16S ribosomal RNA GenBank accession # MK446541; ITS2 GenBank accession # MK441986. BL 17.72, HF 10.56, RC 11.53. Right tegmen removed: 171 teeth, file length 3.4, TL 10.3, TW 4.4. Type deposited in CAS, Entomology Type #19275.

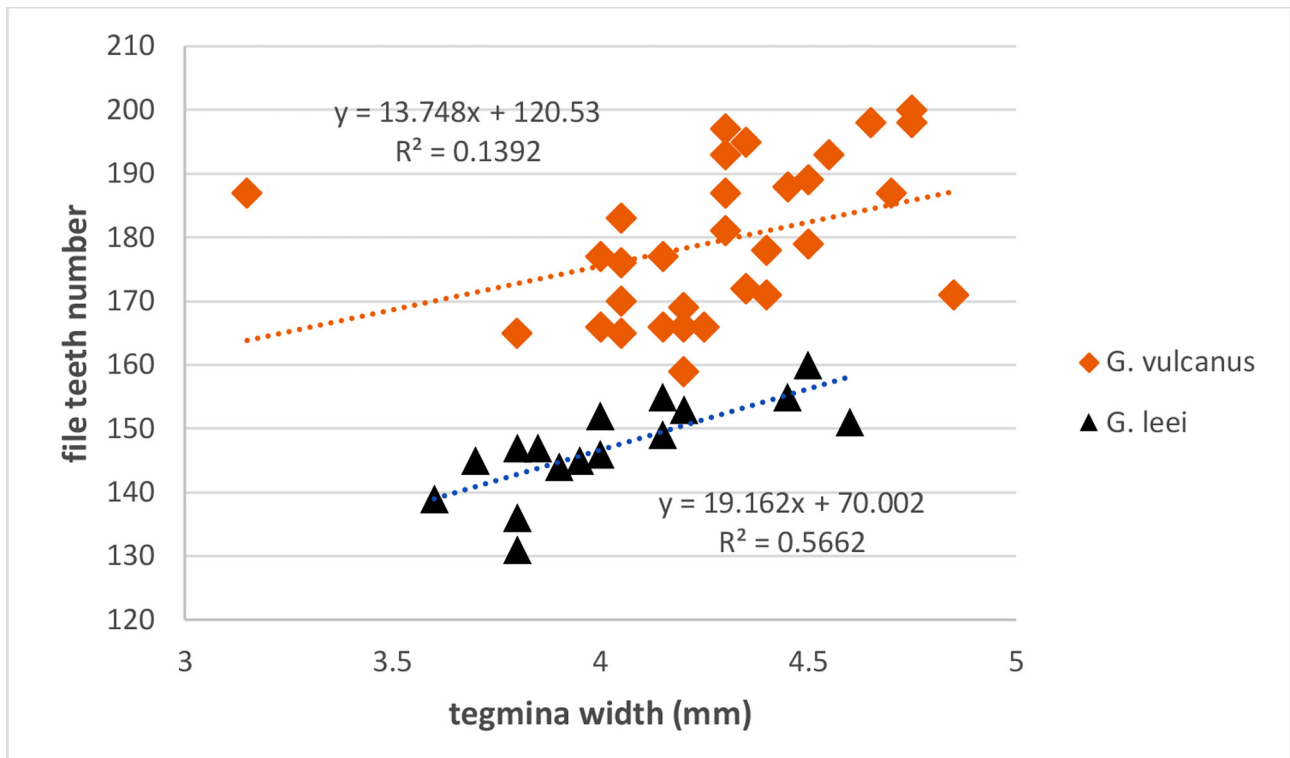


FIGURE 231. Regression tegmina width vs. file teeth number in *G. vulcanus* vs. *G. leei*.

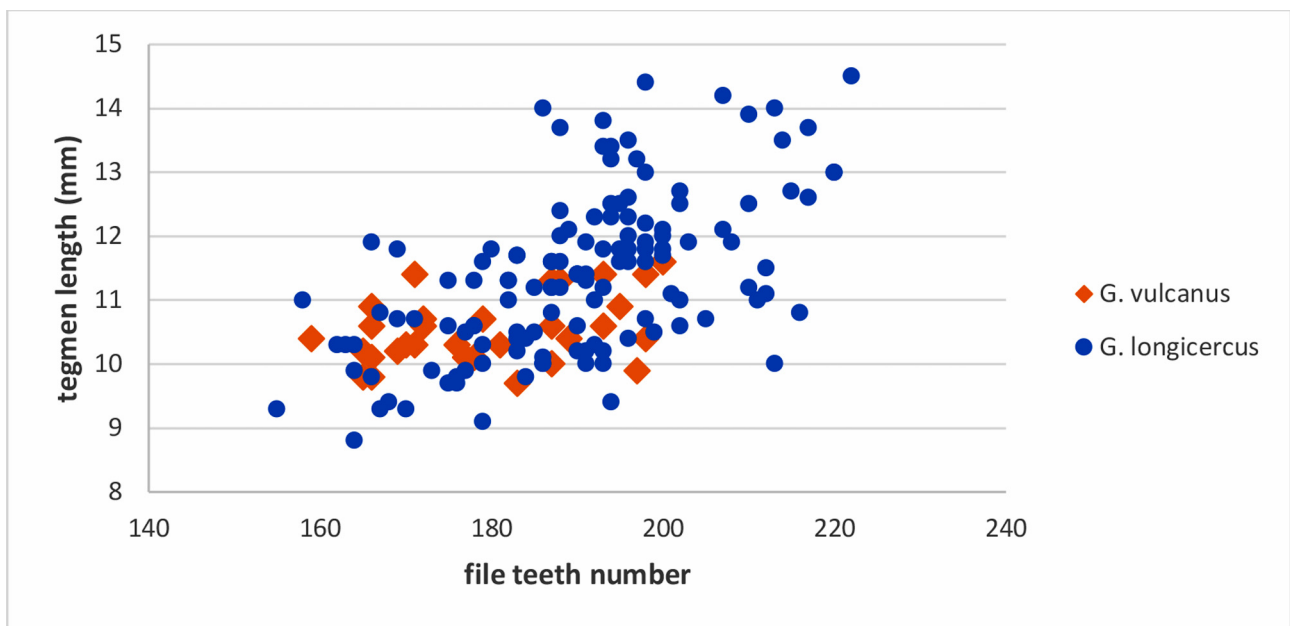


FIGURE 232. Regression file teeth number vs. tegmina length in *G. vulcanus* vs. *G. longicercus*.

Paratypes. (Total: 36♂ 22♀). **New Mexico**, *Cibola Co.*, El Malpais National Monument, type locality, 6870', 18-viii-1993 (S93-71) 6♂ 4♀; 1-vii-1994 (S94-41) 2♂; 1-vii-1994 (S94-42) 2♂; 14-vi-1996 (S96-68) 12♂ 2♀; 14-vi-2007 (S07-52) 2♂ 1♀. *Lincoln Co.*, Valley of Fires State Park along Hwy 380, 5 m W Carrizozo at mile post 60, 5090', 33° 42.115', -105° 56.249', 2-vii-1994 (S94-48) 9♂ 8♀; 13-vi-2007 (S07-46) 3♂ 7♀.

Derivation of name. Named with reference to ancient Roman myth: Vulcan (Latin: Vulcanus) is the god of lava and smoke, including the fires of volcanoes, because lava flows have created this cricket's habitat.

Geographic range. (Fig. 235). The two known localities are separated by about 210 km distance and are not connected by any lava flows visible on Google Earth.

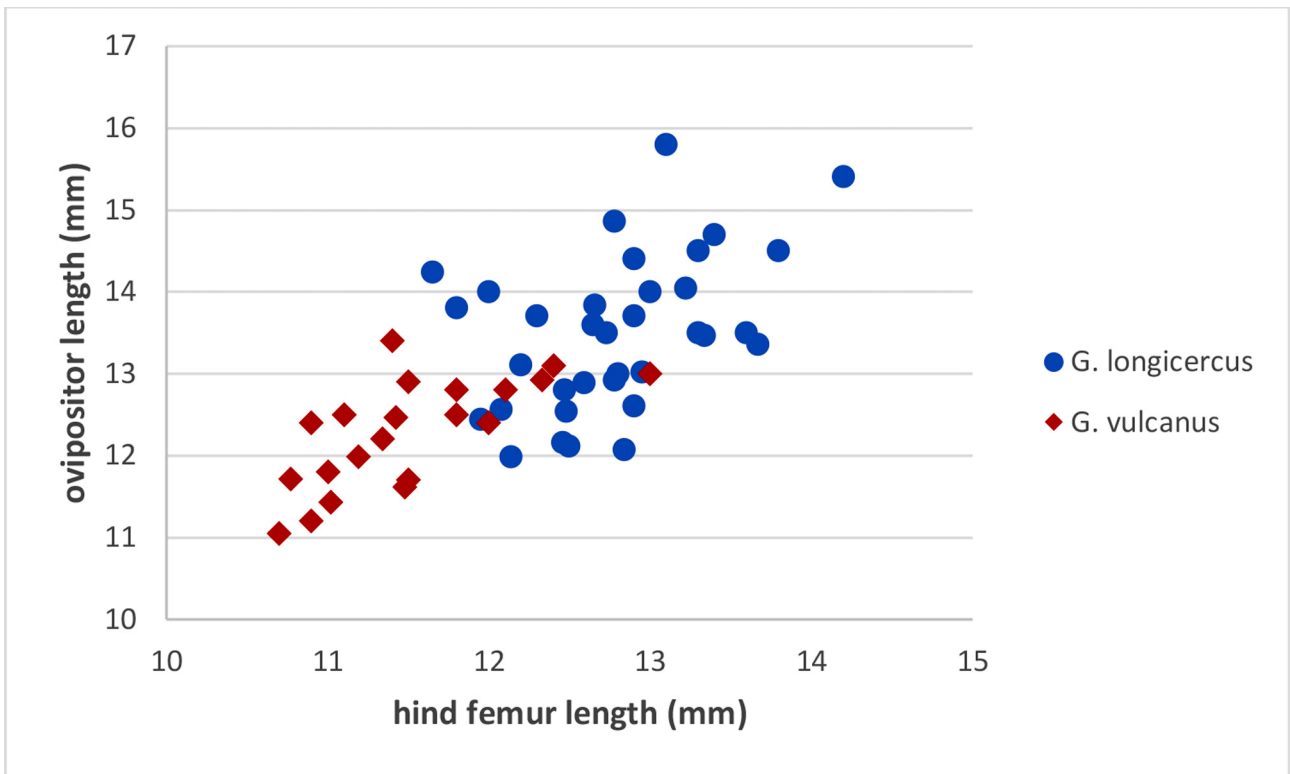


FIGURE 233. Regression hind femur length vs. ovipositor length in *G. vulcanus* vs. *G. longicercus*.



FIGURE 234. Holotype male (left) of *G. vulcanus*. Female (right) also from type locality (S07-52).

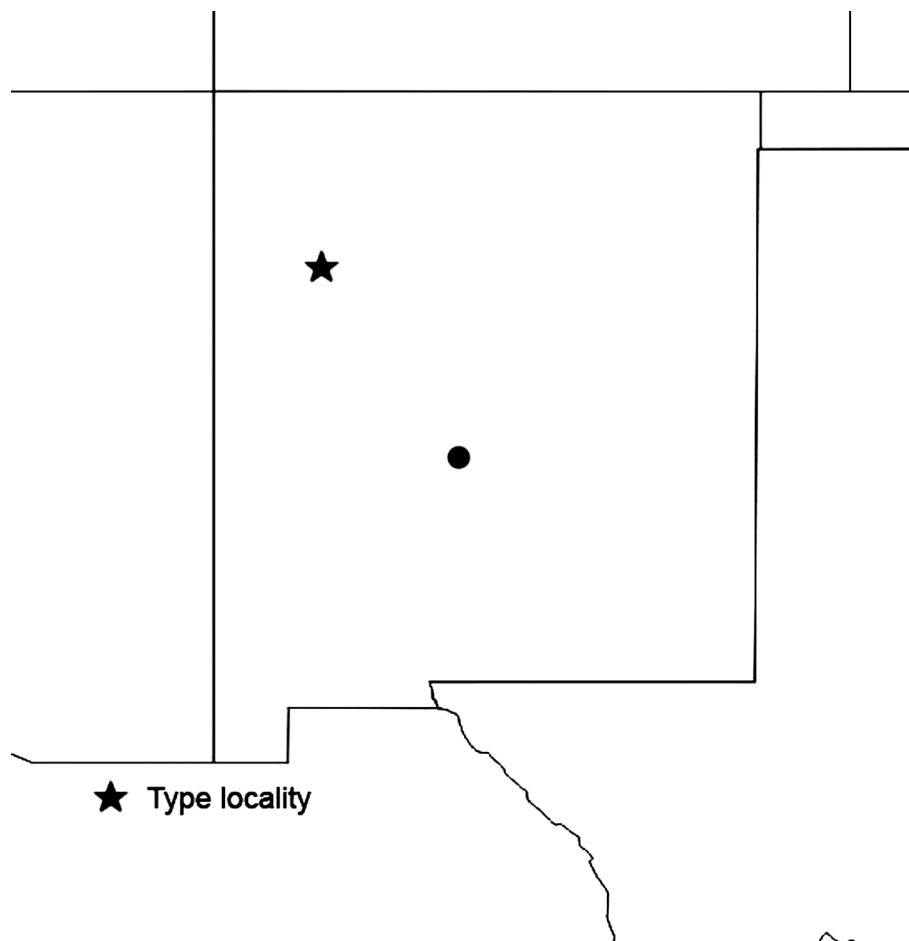


FIGURE 235. Known distribution of *G. vulcanus*.

Habitat. From 1550–2094m elevation. Both lava flow sites are well vegetated with various annuals, shrubs and small trees. The type locality site has bordering grazed grasslands on sandy substrate with pinyon-juniper woodlands nearby.

Life cycle and seasonal occurrence. One generation/year. Adults known from mid-June to mid-August with most August individuals having damaged cerci. It appears that the higher elevation type locality individuals mature before those from Valley of Fires given the presence of many nymphs seen at S07-46 (13-vi-2007) and none ever seen at the type locality on similar dates.

Variation. Body size: lower elevation (1550m elevation) Valley of Fires adults somewhat larger than type locality (2094m elevation) adults.

DNA. Multilocus 2016-025 (type locality) and G1030 (Valley of Fires State Park, S07-46) sister species (Gray *et al.* 2019) to *G. longicercus* from Kofa Mts., Arizona (2016-039, type locality), G1433 (New Mexico, S09-59) and G3386 (Texas, S16-4). ITS2 does not separate *G. longicercus* and *G. vulcanus* (Fig. 224). 16S shows minimal variation either within or between these taxa (509 bp of 16S; N = 10 *G. vulcanus*; N = 69 *G. longicercus*; mean \pm SD Tamura-Nei distance: within *G. vulcanus* = 0.0019 ± 0.0018 , within *G. longicercus* = 0.0016 ± 0.0018 , between *G. vulcanus* and *G. longicercus* = 0.0018 ± 0.0018) and does not separate them.

Discussion. We contemplated the possibility that *G. vulcanus* is simply *G. longicercus* on lava, given the fact that multilocus DNA analysis shows them as sister species. They do separate with the regression of hind femur length vs. ovipositor length (Fig. 233), but this could be explained by the simple fact that *G. longicercus* is a larger cricket. A similar result, and possible explanation, is seen (Fig. 232) when regressing number of file teeth vs. tegmen length. Despite these results, we have decided to treat them as separate species because of two factors: (1) *G. vulcanus*, despite living at higher, cooler elevations, appears to reach adulthood before most populations of *G. longicercus*. Specifically, the entire type locality population of *G. vulcanus* was adult by mid-June and by mid-August, many individuals had damaged cerci, apparently indicating old adult age. In contrast, during several early to mid-June, Arizona field trips, we collected more late instar *G. longicercus* nymphs, than adults, at the following locali-

ties: Mt. Graham (S12-19), Mt. Lemmon (S12-23), and Fort Bowie (S13-19), despite these localities being lower and warmer than the New Mexico *G. vulcanus* sites. (2) Lava flows are not a typical *Gryllus* habitat, as confirmed by our extensive checking of such areas. *G. leei*, from west-central Utah, appears to be another lava exception and is isolated to the Black Rock Desert of western Utah.

Although we treat *G. vulcanus* here as separate from *G. longicercus*, further work is clearly warranted. Especially given the similarity in song, pre-zygotic reproductive isolation, to the extent that it exists, may be driven solely by ecology and/or phenology. Given that the two known lava flow localities in New Mexico are not connected and are of very different ages, we suspect that the two flightless *G. vulcanus* populations represent separate derivations from *G. longicercus*; this also could be tested in future work. DNA markers more sensitive than ITS2 and 16S would be required (e.g. SNPs).

The type locality is part of the 3,000-year-old McCarty lava flow: http://geoinfo.nmt.edu/tour/federal/monuments/el_malpais/zuni-bandera/pahoehoe.html (Laughlin *et al.* 1993). However, volcanism in adjacent areas dates as far back as 115,000 years (Laughlin *et al.* 1994). There are many deep lava cracks and fissures from which *G. vulcanus* sing, making their song soft and the crickets difficult to collect, despite their boldness. With patience, singing males can frequently be coaxed from deep cracks with a slim twig, as they do not dive down. Nevertheless, collecting time is better spent walking the edges of the lava flow at night after laying of an oatmeal trail there during the late afternoon. One male singing from a crack in the ground several meters from lava's edge at El Malpais (S96-68).

Many fewer singing males at Valley of Fires in 2007 (S07-46) than in 1994. At Valley of Fires State Park, there are fewer and more shallow cracks in the surface lava and more dirt and grassy areas within the lava flow area when compared to the type locality. This lava flow has been dated to ca. 5,200 ± 700 years of age (Dunbar 1999). At Valley of Fires all crickets were in the open with many males singing totally exposed away from cracks but still on lava. They were also easy to approach while singing and active jumpers. Many singing males had females near them. In 2007 (13-vi-2007, S07-46), several medium instar nymphs, and adult females, were seen walking around.

The Saxatilis Group

G. saxatilis Weissman & Gray, n. sp.; *G. leei* Weissman & Gray, n. sp.; *G. makhosica* Weissman & Gray, n. sp.; *G. navajo* Weissman & Gray, n. sp.

Sister species of western chirping crickets with similar songs (Figs 236, 237). Most easily separated from each other by habitat and geography: *G. saxatilis* widespread in dry rocky areas west of the Rockies; *G. leei* restricted to lava in Utah; *G. makhosica* restricted to badlands clay habitats in South Dakota; *G. navajo* restricted to the red sandstone region of the Colorado Plateau in Utah and Arizona. At least three additional cryptic species may exist within the Saxatilis Group. Poorly separated by ITS2 DNA (Fig. 238); both COI and 16S likewise proved unhelpful.

Gryllus saxatilis Weissman & Gray, n. sp.

Western Rock-Loving Field Cricket

Figs 205, 236–246, 248, Table 1

Gryllus pennsylvanicus of Weissman *et al.*, 1980.

'*Gryllus* #2' of Rentz & Weissman, 1981.

'G. #2, #11, #22, #38', 'G. mojave', 'G. tulare', 'G. mormoni' of DBW notebooks.

Distribution. Widespread in the western US, west of the Rocky Mountains.

Recognition characters and song. A small to large, short or long hind winged, medium-long cerci rarely longer than ovipositor in situ, slow chirping cricket usually associated with rocky habitats. *Song* (Fig. 239, R15-372) with 3–5 p/c (range 2–7), 50–280 c/m, PR 14-25. Separated from the following western slow chirping *Gryllus* as follows: From *G. longicercus*, which has a distinctive, non-overlapping lower PR, and has more file teeth, longer cerci, and different DNA. From *G. lightfooti* which has a tegminal bar in females, shorter male tegmina, not usually associated with rocks, faster chirp rate, fewer file teeth, and different DNA. From *G. montis* which occurs at higher elevations