

*Habitat.* The Folsom Lake locality is open, short grassland, with rocks, lying in the completely dry, exposed part of “Folsom Lake”, which may have been submerged in 2019 after an above-average rainfall year. A few males also singing from under adjacent rocks at the base of Folsom Dam. Similar sounding males also singing within oak-woodland of Folsom Lake SRA but none collected and species identity not confirmed as similar sounding *G. veletisoides* also occurs in the area. The two localities within Folsom city limits (S15-87, S15-88) were open areas with dirt and few rocks, the latter adjacent to the railroad tracks. Mosquito Road is 37 air km from the first locality and more typical habitat of *G. saxatilis* comprised of oak woodland with dirt road banks but few rocks. Crickets were heard for some 3 km along Mosquito Rd. between 511m and 684m elevation.

*Life cycle and seasonal occurrence.* No egg diapause (S14-77). One generation/year with nymphs overwintering as mid-late instars since late-instars present in late March and adults present and singing in early May. F<sub>1</sub> nymphs, from laboratory laid eggs, started molting to adults, in May, one year after they were laid.

‘**G. tulare**’ Only known from Tulare Co., California, always with short hind wings. Song a slow chirp (3) 4 (5) p/c, 90-225c/m, PR 15.2-23.8 at 25°C. Separated from nominate *G. saxatilis* by DNA (Fig. 238).

*Specimens studied.* (31♂ 17♀). **California.** *Tulare Co.*, Hwy 190 3.2 m E Springville, 1620’, 20-viii-2006 (S06-81) 1♂. Hwy 190 6.5-10 m E Springville, 2320-3460’, 29-v-2009 (S09-34, 35) 17♂ 13♀. Hwy 190 0.5 m W Pierpoint Springs, 4700’, 4-v-2003 (S03-27) 2♂ 2♀. Hwy 190 5.4 m W Pierpoint Springs, 3700’, 4-v-2003 S03-28) 5♂. Hwy 198 4.4 m E Lemon Cove, 725’, 28-vi-2016 (S16-21) 6♂ 2♀.

*Habitat.* From 221-1433m elevation. Habitat typical for *G. saxatilis*: oak-woodland borders, chaparral, road cuts always associated with rocks.

*Life cycle and seasonal occurrence.* One generation/year, egg diapause not checked but undoubtedly absent as adults present in late spring. Mid-late instars seen early May (S03-27 & 28) and a last instar female seen late May (S09-35) when most of population adult.

*Variation.* **Cerci length:** Longer than ovipositor in situ in only one female (S09-34). **Color:** Hind femur normally varies from small reddish area medially where attaches to body to entire femur reddish with rest of hind leg black. Two males (S03-27 and S06-81) with entire hind legs reddish. **File teeth:** Vary from 122–174. All of these males have medium length cerci and DNA consistent with ‘*G. tulare*.’ The three *G. saxatilis* males with the fewest teeth (122–149, see Fig. 244, p. \_\_\_) are in this ‘*G. tulare*’ group (S03-28, W Pierpoint Springs), collected on 4-v-2003, and raised through the last few instars in the laboratory.

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

Utah Lava Field Cricket

Figs 231, 236–238, 240, 247–250, Table 1

*Distribution.* Known only from lava flows in the Black Rock Desert of west-central Utah.

*Recognition characters and song.* A small-medium, always short hind winged, generally black, shiny pronotum, small headed, short ovipositor, cerci always longer than ovipositor in situ *Gryllus* (Fig. 249). *Song* a chirp (Fig. 247, R17-7) of usually 4 (range 3–5) p/c, PR 17.5–22, CR 105–200 (range 98–225). Most importantly, because multilocus *G. leei* maps close to multilocus *G. saxatilis*, we can separate the two even though they are found only ~14 air km from each other, as follows: *G. leei* is smaller (S01-28, S17-6), with the longest body-length individual being shorter than the smallest individual of *G. saxatilis* (S01-30, S17-7), with good sample sizes from both populations. If the same species, it then logically follows that *G. leei* might have (see Table 1, p. 18) fewer file teeth, shorter files and shorter tegmina, and (non-overlapping) shorter ovipositors than nearby *G. saxatilis*. What doesn’t necessarily follow is that *G. leei* has proportionally longer cerci, almost non-overlapping teeth/mm, and a different dominant frequency calling song. For the latter, 24 males from the type locality (S17-6) had a dominant frequency from 4017–5211 Hz while 15 males *G. saxatilis* from nearby (S17-7) had a dominant frequency of 3593–4097 Hz. Most male *G. leei* (20 of 22–91%) with 3–4 (rarely 5) harp veins while 12 of 13 (92%) nearby *G. saxatilis* have 4–5 (rarely 3) harp veins. Additionally, the cerci are longer, in situ, than the tip of the ovipositor in all 14 type locality females of *G. leei* while shorter than the tip in all 10 females of nearby (S17-7) *G. saxatilis*. This trend is confirmed when we regress ovipositor length on hind femur length (as an indicator of body size) (Fig. 248; hind femur:  $F_{1,20} = 87.72$ ,  $p < 0.0001$ , species:  $F_{1,20} = 81.16$ ,  $p < 0.0001$ , species\*hind femur  $F_{1,20} = 0.10$ ,  $p = 0.748$ ).

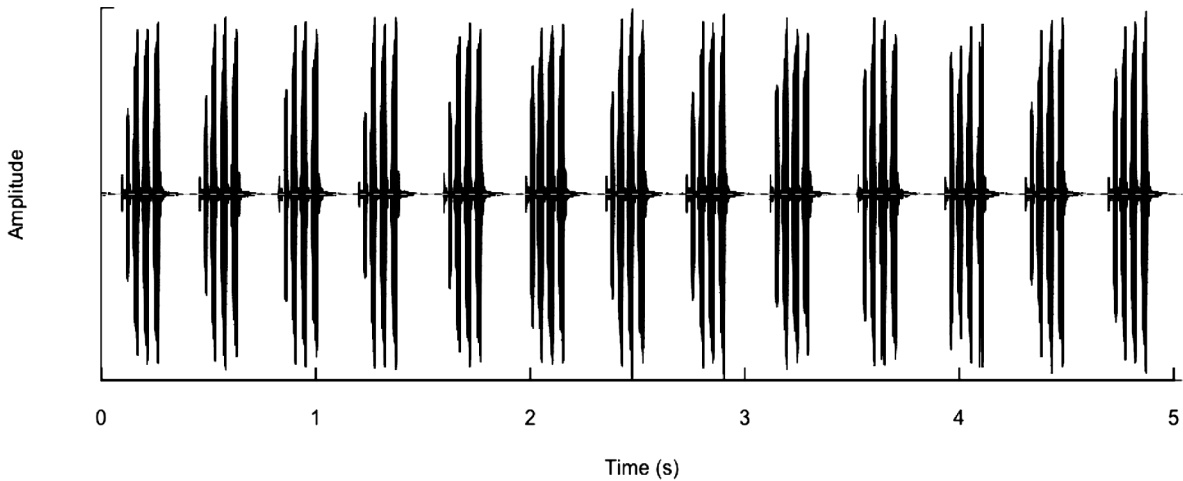


FIGURE 247. Calling song (R17-7) of *G. leei* from type locality (S17-6), recorded at 24.5°C.

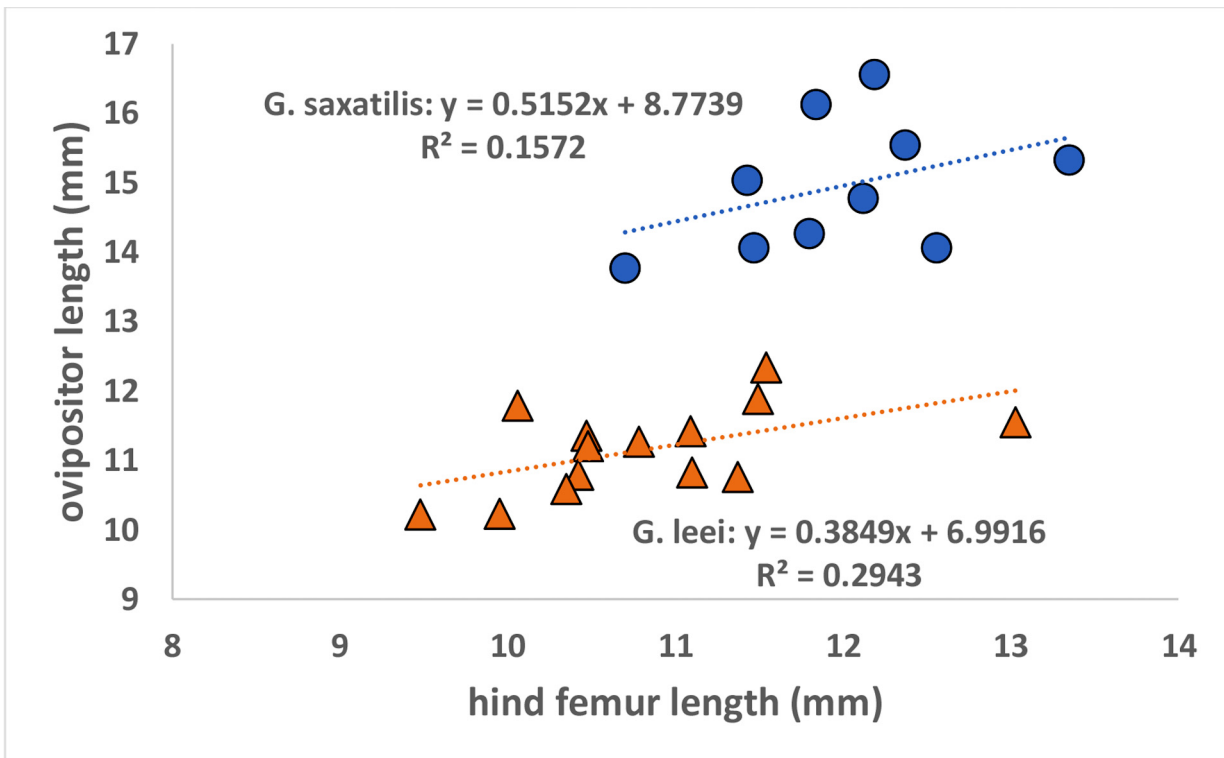


FIGURE 248. Regression of hind femur length vs. ovipositor length in *G. saxatilis* vs. *G. leei* from populations separated by only 14 kilometers.

If individuals from both populations were the same species, even if with different body lengths, we would expect them to fall on the same regression line with a similar Y axis intercept. Apparently living in lava flows favors a shorter ovipositor than living off of lava, even if both species probably oviposit into the soil. There is also evidence that these smaller and lower elevation *G. leei* (S17-6) may molt to adult before *G. saxatilis* in central Utah (S17-7): 29 of 37 (78%) *G. leei* individuals collected on 20-v-2017, at 1418m, were adult while 12 of 24 (50%) *G. saxatilis* individuals collected on the same date, at 1598m, were adult. On the other hand, perhaps the larger *G. saxatilis* simply take longer to become adult because they are larger, as indicated by their longer hind femur lengths.

Distinguished from a number of allopatric lava and rock-associated *Gryllus* as follows: From New Mexico lava *G. vulcanus*, no overlap (Table 1, p. 18) in number of teeth and PR and different DNA. From rock *G. longicercus*,

almost no overlap in number of teeth, PR, cerci length, and DNA. From allopatric eastern Utah *G. navajo* by habitat (sandstone badlands vs. lava), general body and tegmina color (reddish vs. black), antennae length longer than body in *G. navajo*, and the Pahvant Mt. Range and Sevier Plateau between the two species. From allopatric South Dakota badlands *G. makhosica*, no overlap in file length, teeth/mm, tegmina length and width, hind femur length, ovipositor length and PR. From allopatric Texas rock *G. transpecos*, distinguished by *G. leei*'s smaller size, slower PR, shorter ovipositor, habitat, and DNA with the nearest populations separated by some 1110 km. *G. veletis* sympatric with *G. leei* but can be easily separated by the former's shorter cerci which never approach the ovipositor tip in situ, being located away from lava, and more robust, larger body size.

*Holotype*. Male (Fig. 249): Utah, Millard Co., 2.05 m NW Flowell and 8.5 m NW Fillmore, 20-v-2017, 4653', 38° 59' 52.30" -112° 27' 32.94". D.B. Weissman, D. W. Weissman. S17-6, R17-6. DNA sample G3480. BL 17.44, HF 9.46, RC 11.07. Right tegmen removed: 3 harp veins, 144 teeth, file length 2.8, TL 9.5, TW 3.9. Type deposited in CAS, Entomology Type #19277.



**FIGURE 249.** Holotype male (left) of *G. leei*. Female (right) also from type locality (S17-6).

*Paratypes*. (Total: 30♂ 14♀). Same locality data as holotype: 18-v-2001 (S01-28) 7♂ 4♀; 20-v-2017 (S17-6) 23♂ 10♀.

*Etymology*. Named for Vincent F. Lee of the CAS, for helping to collect the initial series and for never complaining, during many field trips, when asked to help collect “one more cricket” at 04:30.

*Geographical range*. See Fig. 250. Known only from the type locality.

*Habitat*. Many males sing from deep crevices and cracks, within vegetated lava flows, where they are almost impossible to catch, even using water for flushing. Fortunately, a good number of juvenile and adult males and females were under lava rocks that were resting on soil, around edges of main lava flow. Walking into the lava field at night, we heard males singing more than 50 meters from lava's edge on 20-v-2017, although not as common as on the lava's perimeter. Utah's Black Rock Desert volcanic field is a heterogeneous mix of flows from 6.1 MYA with continuous activity from 2.7 MYA to the present, including the most recent eruptions 720 years ago (USGS: [https://volcanoes.usgs.gov/volcanoes/black\\_rock\\_desert/](https://volcanoes.usgs.gov/volcanoes/black_rock_desert/)).

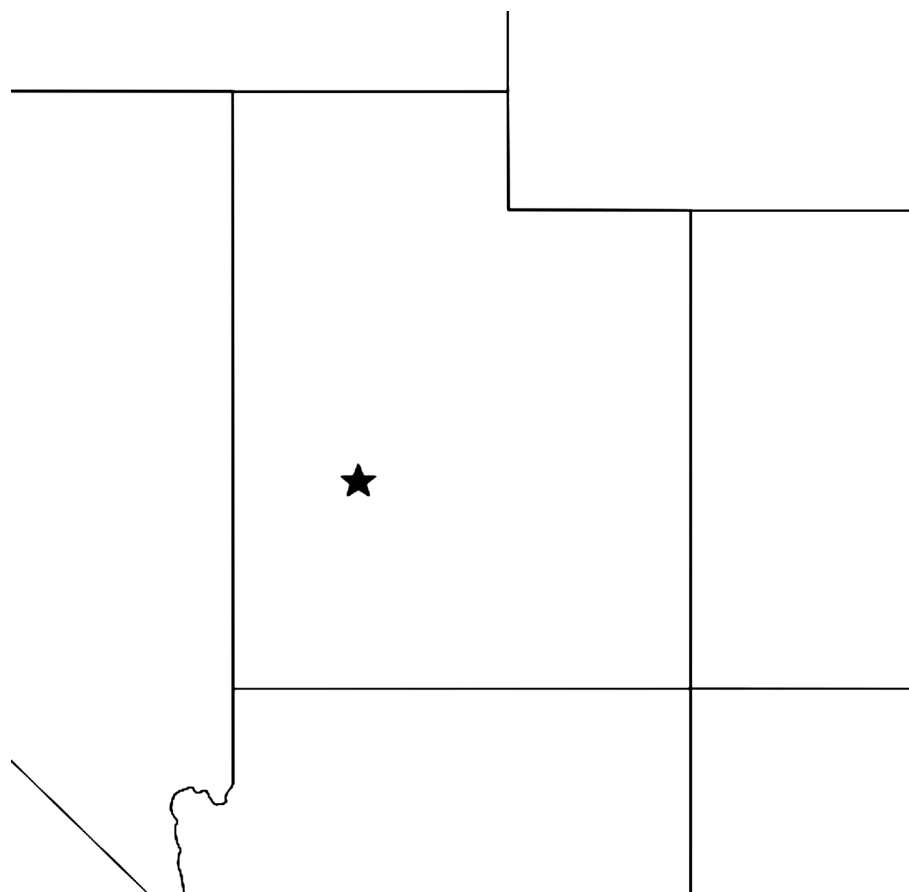


FIGURE 250. Known distribution of *G. leei*.

*Life cycle and seasonal occurrence.* No egg diapause (S17-6). Probably one generation/year, overwinter as late instars with first adults probably appearing in early-May. No nymphs seen when series collected 18-v-2001, despite a cool, wet spring in Utah. On 20-v-2017, we collected 22 adult males, 7 adult females, and 8 late instars. Also listened here 19-iv-1999 and 11-ix-1998 (apparently too late) without hearing any singing males.

One generation/year also supported by these observations: Adults collected May 20<sup>th</sup> were maintained together under ambient light conditions, at fluctuating temperatures between 18-30°C, and allowed to mate. Females were then isolated in cartons with moist sand, for oviposition, starting on May 30. Very good egg hatch commenced on June 26, indicating the absence of an obligate egg diapause. Many, but not all, nymphs in both cultures grew rapidly with the first adults appearing around September 12<sup>th</sup> in both containers, confirming the possibility of 2 generations/year. Still, a fair number of nymphs were only mid-instar in mid-September. So, while this species could have 2 generations/year, on site observations support a univoltine species. And we wonder if *Gryllus* in areas with monsoon rains have more variability in instar development than those in California with its more predictable drought periods of a Mediterranean climate?

*Variation. Color:* Variable amount of red on inner rear leg femur. Two of 10 2017 females with tegminal bars.

*DNA.* Multilocus G147 (S01-28) and G3475 (S17-6) map (Gray *et al.* 2019) with sister taxa *G. saxatilis* (G3484, S17-7, from 14 km E of type locality and the closest population of *G. saxatilis* to the type locality of *G. leei*), G1067 *G. navajo*, and G1340 *G. makhosica*. ITS2 gives (at best) modest separation of *G. leei* from *G. saxatilis* (Fig. 238, p. 236).

*Discussion.* Singing on arrival at type locality at 18:00 on 18-v-2001 and 19:00 on 20-v-2017, well before sunset. Lava flows in this area from 600 to 15,500 years old (White 1996). The main flow measures, on Google Earth, some 8.5 km wide north to south and 9 km wide east to west. The lava bed is like an island separated from the surrounding flat plains without rocky, suitable habitat for *G. saxatilis*.

There is one other lava flow obligate *Gryllus* in the western US: *G. vulcanus* from New Mexico. But not all lava flows are inhabited by *Gryllus*: at extensive lava flows in Lake Co., SE Oregon (43° 35.5' -121° 1.43'), no *Gryllus* heard 1-vi-1997 despite area looking favorable.



We wonder if the short ovipositor is related to living in lava fields with shallow substrate for oviposition? It would be of interest to know if *G. leei* females oviposit directly into the substrate or can they use pockets of soil and debris within the lava field?

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

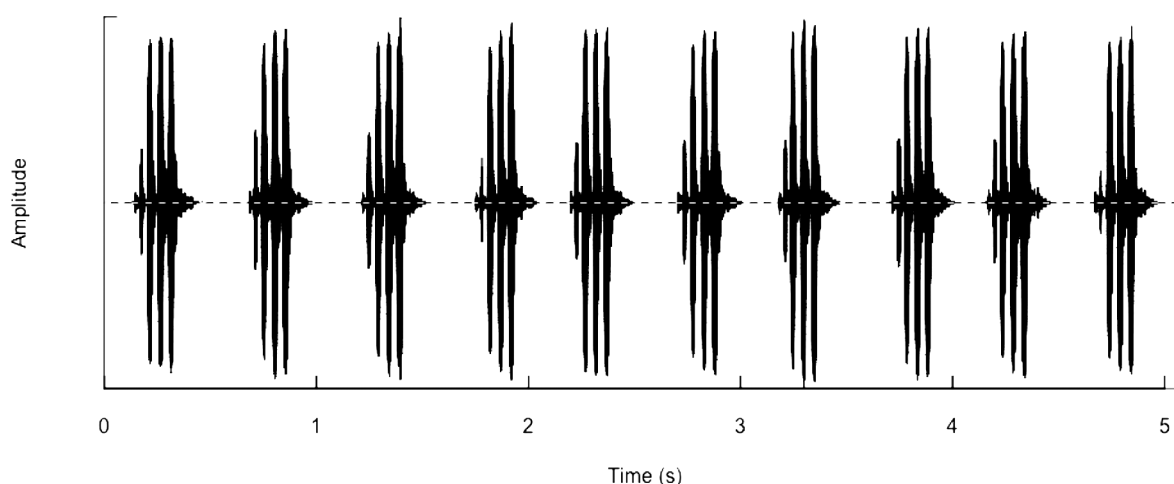
Badland's National Park Field Cricket

Figs 236–238, 251–258, Table 1

'G. #26' of DBW notebooks

*Distribution.* Known only from Badlands National Park, South Dakota.

*Recognition characters and song.* A medium sized, slender, always short hind wings, dark colored, long antennae extending well past tip of ovipositor, females with short tegmina and cerci longer than ovipositor in situ. *Song* (Fig. 251, R09-95) a chirp, 3–4 (range 3–5) p/c, 105–185 c/s, PR 16–21. Distinguished from allopatric (nearest populations are ~850 km apart) sister species *G. navajo* from Utah and Arizona by the following: general body color, especially hind femurs, more reddish in *G. navajo* vs. dark in *G. makhosica*. *G. navajo* lives in sandstone badlands vs. clay badlands for *G. makhosica*. Chirps in *G. makhosica* average 3–4 p/c vs. 4–5 in *G. navajo*. Morphologically, *G. makhosica* has more teeth and longer files on average than *G. navajo* (Fig. 252), more teeth and average longer tegmina (Fig. 253), more teeth but similar male hind femur length (Fig. 254), more teeth and less variable teeth/mm (Fig. 255), while female *G. makhosica* appear to have, on average, longer hind femurs and less variable ovipositor lengths (Fig. 256). While there is overlap in all of these metrics for these two species (Table 1, p. 18), *G. makhosica* is not a larger cricket than *G. navajo* as indicated by similar hind femur lengths in males (Fig. 254). Distinguished from allopatric (nearest populations are >520 km apart), rock loving sister species *G. saxatilis* with latter having file with more teeth and longer tegmina, longer cerci and longer ovipositor. Distinguished from allopatric (nearest populations over 1000 km apart), lava inhabiting sister species *G. leei* by *G. makhosica* having non-overlapping and longer files, tegmina length, and ovipositors. Distinguished from allopatric (nearest populations are >1100 km apart) *G. longicercus* by DNA and former having fewer teeth in file, fewer teeth/mm, and non-overlapping ovipositor length and pulse rate (Table 1, p. 18).



**FIGURE 251.** Calling song (R09-95) of *G. makhosica* from type locality (S09-89), recorded at 24.5°C.

*Holotype.* Male (Fig. 257): South Dakota, Jackson Co., Badlands National Park, Cedar Pass Overlook area, 3-vii-2009, 2680', 43° 45' 13.6" -101° 56' 5.1". DB Weissman & DC Lightfoot. S09-89, R09-80, DNA sample G1340. 16S GenBank accession # MK446488; ITS2 GenBank accession # MK441894. BL 20.29, HF 11.89, LC 14.81. Right tegmen removed: 172 teeth, file length 4.0, TL 13.2, TW 5.4. Type deposited in CAS, Entomology Type #19265.