

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).

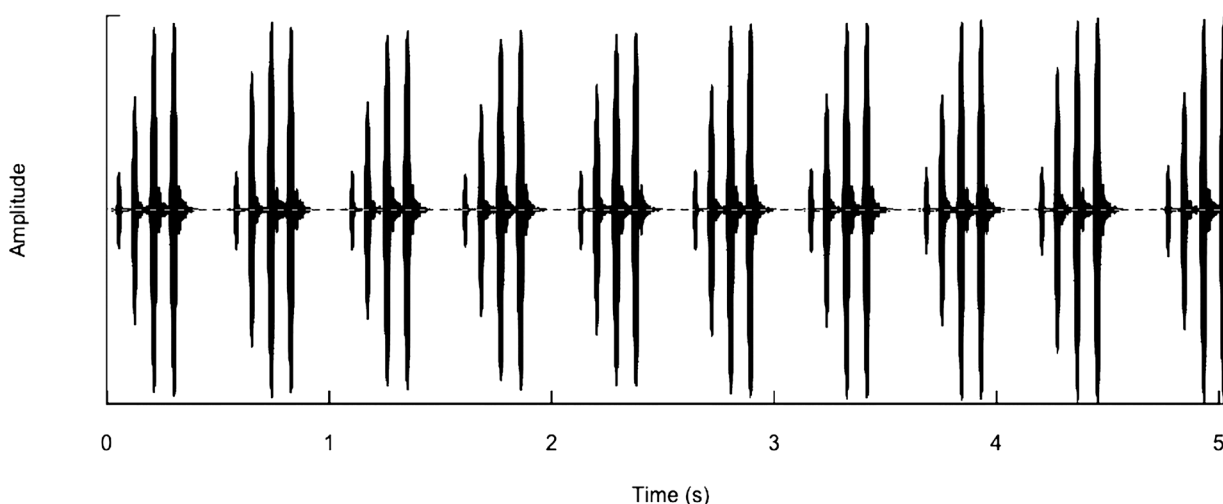


FIGURE 230. Calling song (R07-68) of *G. vulcanus* from type locality, recorded at 25°C.

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.

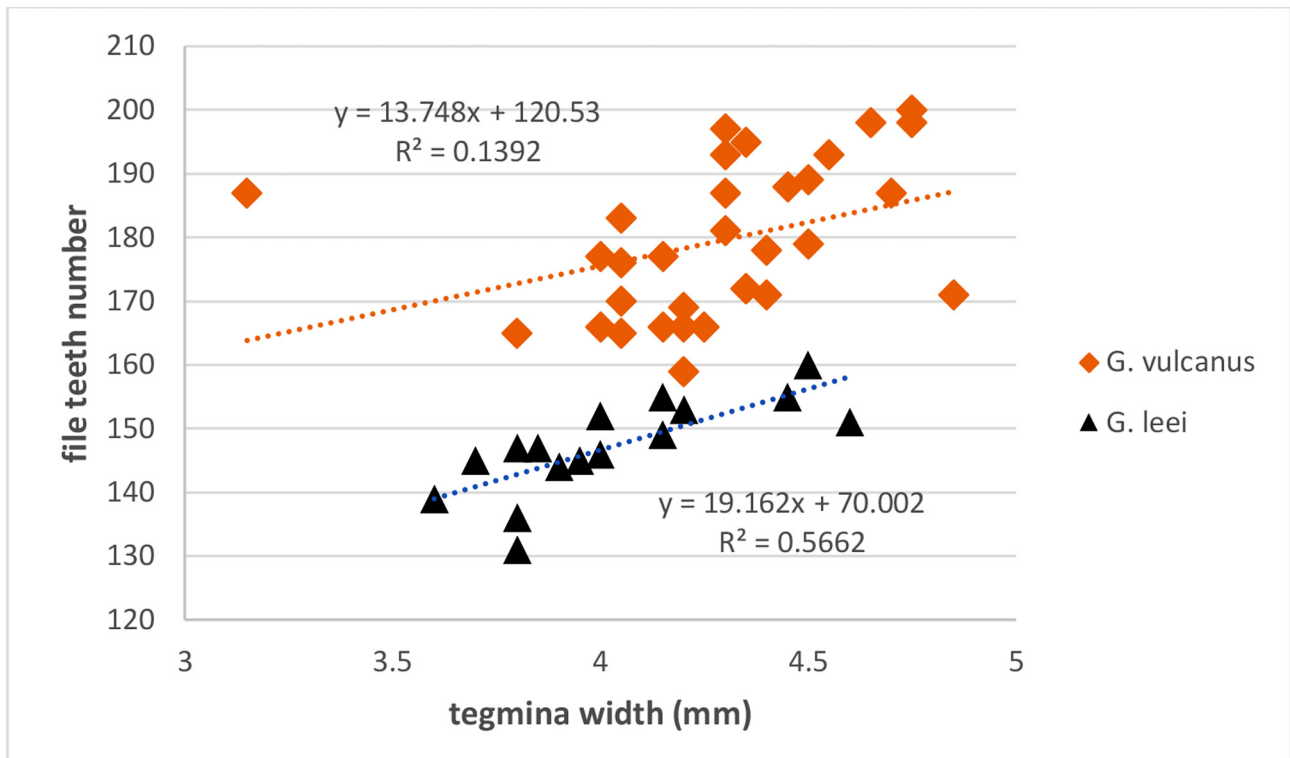


FIGURE 231. Regression tegmina width vs. file teeth number in *G. vulcanus* vs. *G. leei*.

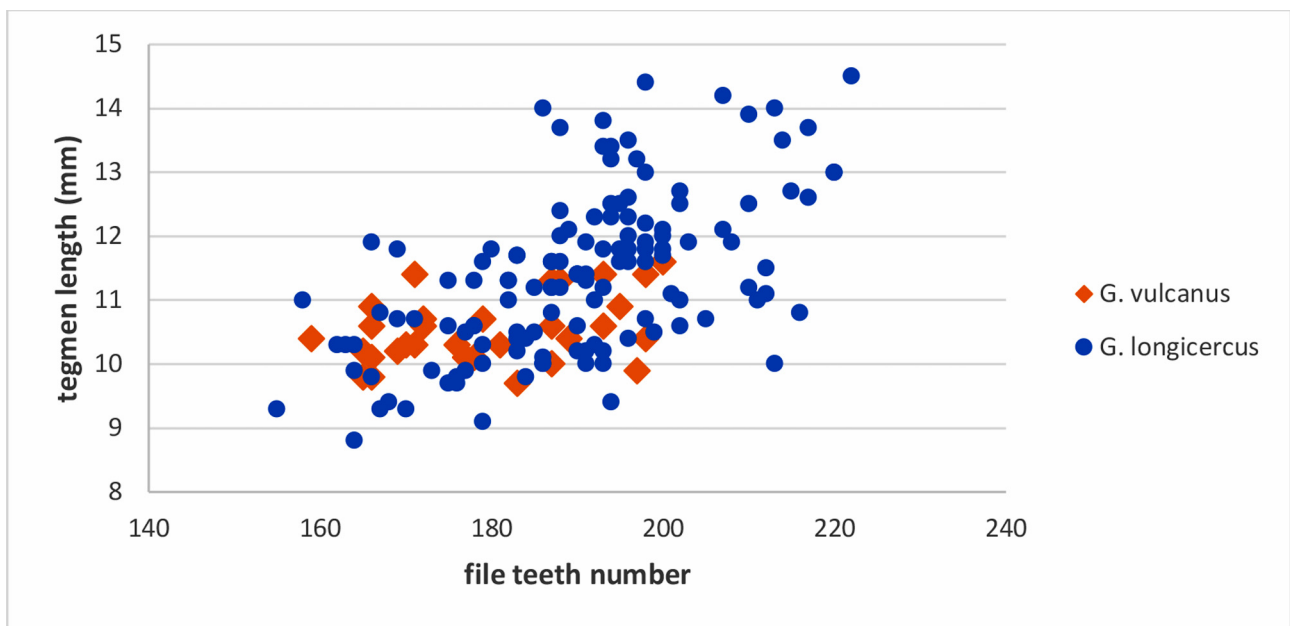


FIGURE 232. Regression file teeth number vs. tegmina length in *G. vulcanus* vs. *G. longicercus*.

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.

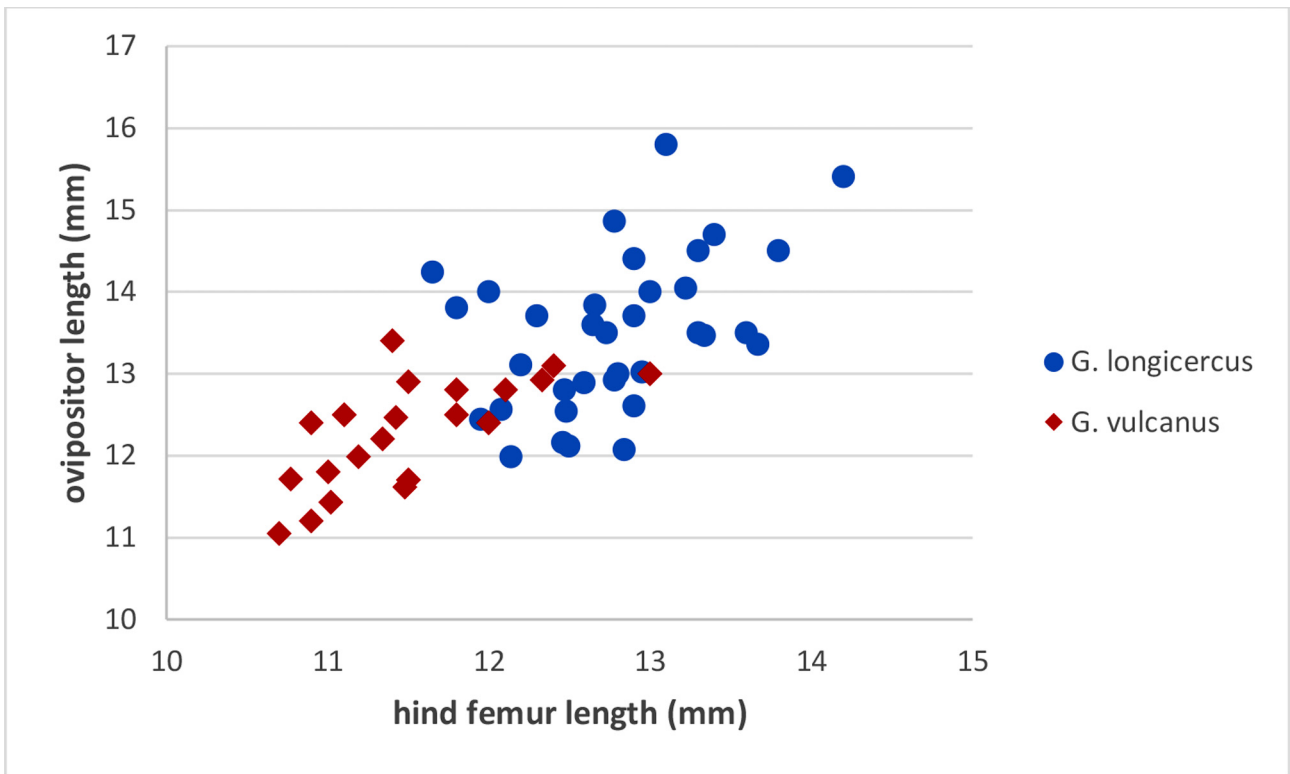


FIGURE 233. Regression hind femur length vs. ovipositor length in *G. vulcanus* vs. *G. longicercus*.



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

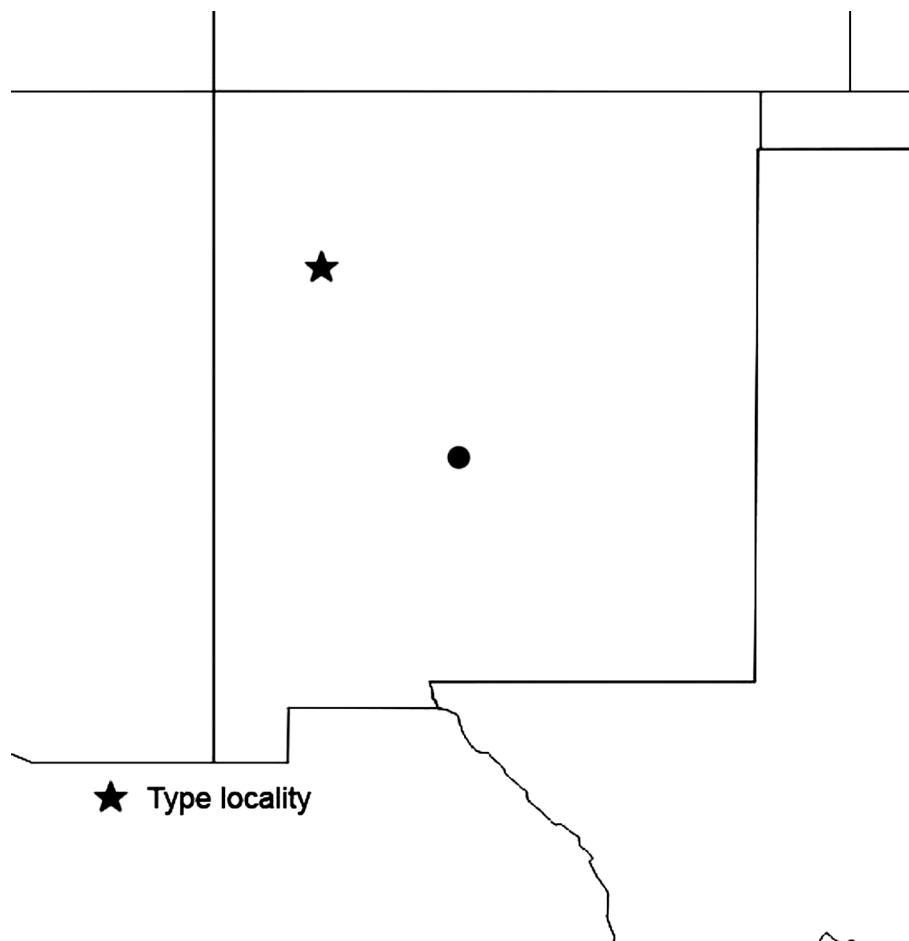


FIGURE 235. Known distribution of *G. vulcanus*.

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