on the head adjacent to the eyes. These color patterns are also seen in *G. lightfooti* from Southern CA (S16-31). We have not explicitly compared nymphal color patterns between different *Gryllus* species (but see discussion of striped nymphs under the Longicercus Group, p. 229), although such information might prove phylogenetically relevant.

We have documented parasitoid tachinids *Ormia ochracea* at the following Arizona localities: near Alamo Lake (S11-86), Mt. Graham (S15-100), Willcox Playa (S15-104), Brown Canyon (S15-105), and Painted Rock Petroglyph Site. We believe that the distorted adult sex ratios (e.g. Brown Canyon, S15-105; W of Sells, S15-108) seen later in the season, where adult females greatly outnumber adult males, may be related to the high incidence of tachinid-killed males (Sakaguchi & Gray 2011). Also, not singing at night, when gravid tachinid female flies are most active and acoustically searching for singing male *Gryllus*, should help protect adult males that can still find adult females due to high population densities. DC Lightfoot (pers. comm. to DBW, 6/2017) also reports laboratory males singing more in afternoon and early evening than later at night.

***Gryllus sotol* Weissman & Gray, n. sp.**
Organ Mountains Field Cricket
Figs 207–209, 213–215, Table 1

FIGURE 213. Holotype male of *G. sotol.* Female also from type locality (S17-4).

Distribution. Known only from the sky island Organ Mountains of south central New Mexico, above 1520m.

Recognition characters and song. A medium to large, always short hind winged, generally black (except for inside of hind femur) cricket, whose cerci are always shorter than tip of ovipositor in situ (Fig. 213). Intimately associated with sotol, *Dasylirion wheeleri*, from which it frequently sings during the daytime. *Song* (Fig. 214) a slow chirp, usually 3–5 p/c (range 3–6), with a chirp rate of 120–160 (range 82–170) and a PR of 16.5–22.7 at 25°C. Dominant frequency 3463–4746 Hz. Distinguished from other Southwestern slow chirping *Gryllus* as follows: from microsympatric *G. longicercus*, which it greatly outnumbers, by (generally) having non-overlapping and lower file teeth number (Table 1, p. 18), higher PR, and shorter cerci never longer than ovipositor tip in situ (almost always longer in *G. longicercus*). Separated from more eastern, allopatric sister species *G. transpecos* (although some

individuals [those in Clade 1—see below] with similar ITS2 DNA [see Fig. 209]), *G. sotol* has more teeth, higher tooth density, shorter cerci never as long as ovipositor tip (almost always longer in *G. transpecos*), slower PR, and habitat: open, lower elevation, drier, rocky Chihuahuan Desert for *G. transpecos* versus higher, cooler, low mountain bajadas and woodlands, with sotol, for *G. sotol*. Additionally, *G. sotol* frequently climbs into sotol while *G. transpecos* is only found on the ground, although sometimes on rocky cliff faces in road cut areas. Separated from lower elevation, also arboreal, later maturing (despite lower elevations and warmer habitat), more open Chihuahuan and Sonoran Desert grassland sister species *G. lightfooti*, although some individuals (those in Clade 2—see below) with similar ITS2 DNA (see Fig. 209), *G. lightfooti*, often associated with *Yucca elata*, have longer cerci usually as long as ovipositor tip in situ, and females usually with light tegminal bar (of 21 *G. sotol* females collected in 2017, only 2 have slight indications of tegminal bars despite their bodies being solid black, which would accentuate any overlying tegmina bar). Additionally, late instar *G. sotol* abdomens frequently with circular, dorsal stripes while those of *G. lightfooti* are usually tan and blotched. Separated from sky island *G. planeta* from the Davis Mts., in western Texas, by the latter's shorter cerci and oak-forested habitat and distinct multilocus DNA (Gray *et al.* 2019). Separated from allopatric, earlier maturing (despite higher, cooler elevation), more western *G. montis* by multilocus DNA (Gray *et al.* 2019), more teeth/mm in *G. sotol*, and habitat, with *G. montis* occurring under mountain-top trees and *G. sotol* occurring in more open Chihuahuan Desert. Separated from more western *G. saxatilis* by the latter's longer cerci, habitat (likes rocks and almost never up in plants) and DNA. Separated from more western *G. vulcanus* by lower, non-overlapping PR in the latter and differences in habitat (sotol obligate vs. lava bed obligate) and multilocus DNA (Gray *et al* 2019). Separated from *G. leei* by habitat (sotol obligate vs. lava bed obligate) and multilocus DNA.

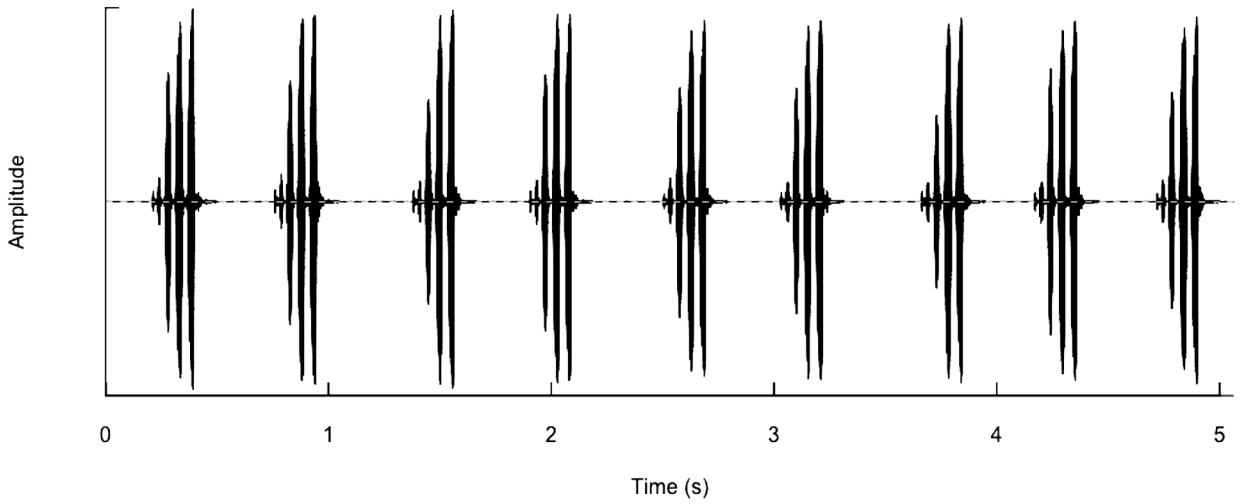

FIGURE 214. Calling song (R17-44) of *G. sotol* from type locality (S17-4), recorded at 24.1°C.

Holotype. Male (Fig. 213): USA, New Mexico, Dona Ana Co., Organ Mountains-Desert Peaks National Monument, Aguirre Springs Campground, 3-vii-2017, 5807', 32° 22' 12.72" -106° 33' 41.18". D.B. Weissman, D.W. Weissman. S17-4, R17-26, DNA (ITS2 and multilocus) sample G3493. GenBank accession # ITS2: MN136862. BL 20.66, HF 11.89, right cercus 12.63. Right tegmen removed: 152 teeth, file length 3.3, TL 10.9, TW 4.3. Type deposited in CAS, Entomology Type #19279.

Paratypes. (total 33♂ 36♀) Type locality, 24-vi-1985 (S85-93), D.C. Lightfoot, 2♂ 3♀; early June, 1994 (S94-29), D.C. Lightfoot, 9♂ 6♀; 3-vii-2015 (S15-77), 4♂ 4♀; 19-v-2017 (S17-4) 17♂ (including holotype) 23♀, most raised from late instars.

Derivation of name. Named for its association with sotol, *Dasylirion wheeleri*, in the Organ Mts. Sotol is a distilled spirit made by a process similar to that for mescal.

Geographical range. Currently known only from the Organ Mts. (Fig. 215), however the Transmountain Road through the Franklin Mountains to the south of the Organ Mountains, should be checked for *G. sotol* in the appropriate habitat. Highest peak there is almost 2194m.

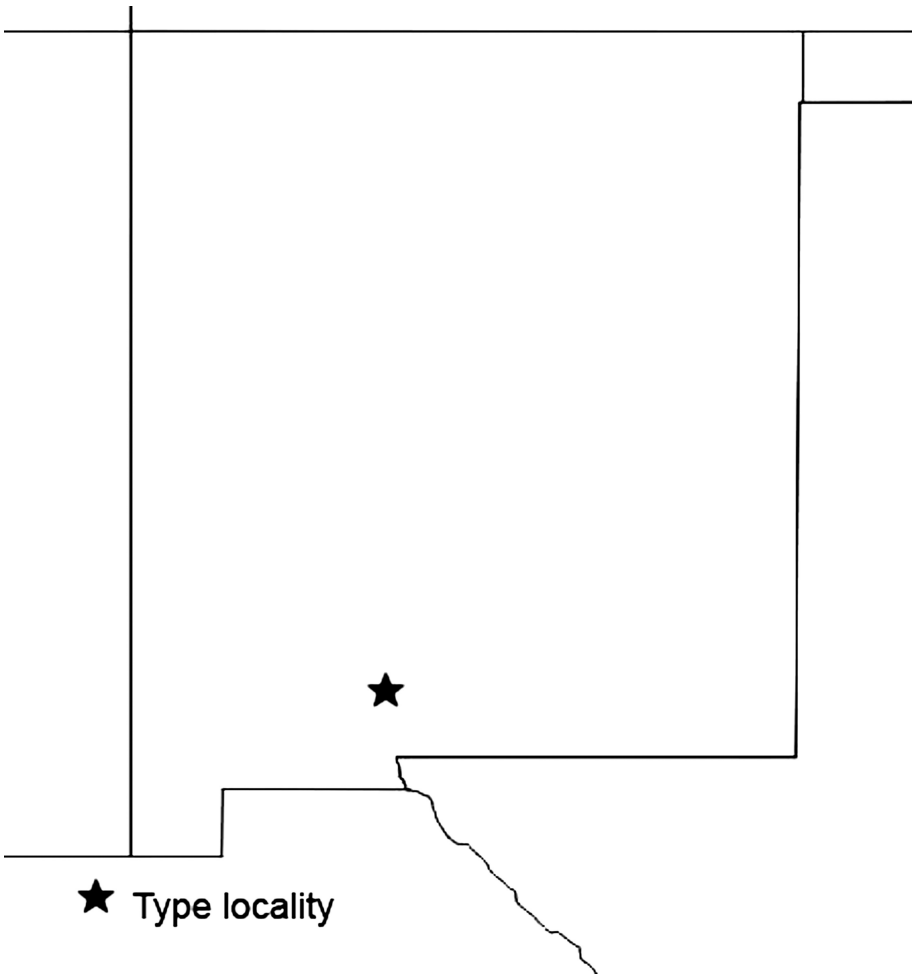

FIGURE 215. Known distribution of *G. sotol*; known only from the type locality in NM despite extensive sampling of nearby regions.

Habitat. Type locality with short oaks and other trees, various shrubs, sotol, and some cactus. The site is at the transition of two Level IV, Chihuahuan Desert ecoregion zones: 24c (Low Mountains and Bajadas) and 24d (Chihuahuan Montane Woodlands). See https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-state.

Life cycle and seasonal occurrence. No egg diapause (S17-4). Apparently one generation/year in the field, based on our observations of them overwintering as mid-late instars with first adults appearing mid-May. Few adult males heard singing during spring stops in 1994 (early June) and 2017 (May 19th) but oatmeal laid on dirt trails in campground area, during both visits, resulted in many late instars being collected. No singing males were heard during mid to late-summer nighttime visits on 17-viii-1993 (S93-70) and DC Lightfoot visit on 16-ix-2018, consistent with one generation/year. And, most importantly, no nymphs and only 1 adult female came to 7 kg of oatmeal on 16-ix-2018.

Interpretation of this apparently straightforward field situation is complicated by laboratory data: Nymphs collected May 19, 2017, were raised to adult under ambient light conditions, at fluctuating temperatures between 18-30°C, and allowed to mate. Adult females were then isolated in cartons with moist sand, for oviposition, starting on June 13 and June 24. Very good egg hatch commenced on July 8 and July 13, respectively, 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 12th in both containers, confirming the possibility of 2 generations/year. Males were heard singing starting on September 16. Still, a fair number of nymphs were only mid-instar in mid-September. So, while this species could have 2 field generations/year, on-site observations are necessary to confirm if those results from 1993 and 2018 are representative of most seasons.

We believe the following could explain this puzzling situation: *Gryllus* eggs need to absorb liquid water, from the substrate, to grow (Hinton 1981). Oviposition into constantly moist sand satisfies this requirement and can re-

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. sotol* 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. sotol* ITS2 clade, suggests that *G. sotol* 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 sotol 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. sotol* 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 sotol 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 sotol 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.